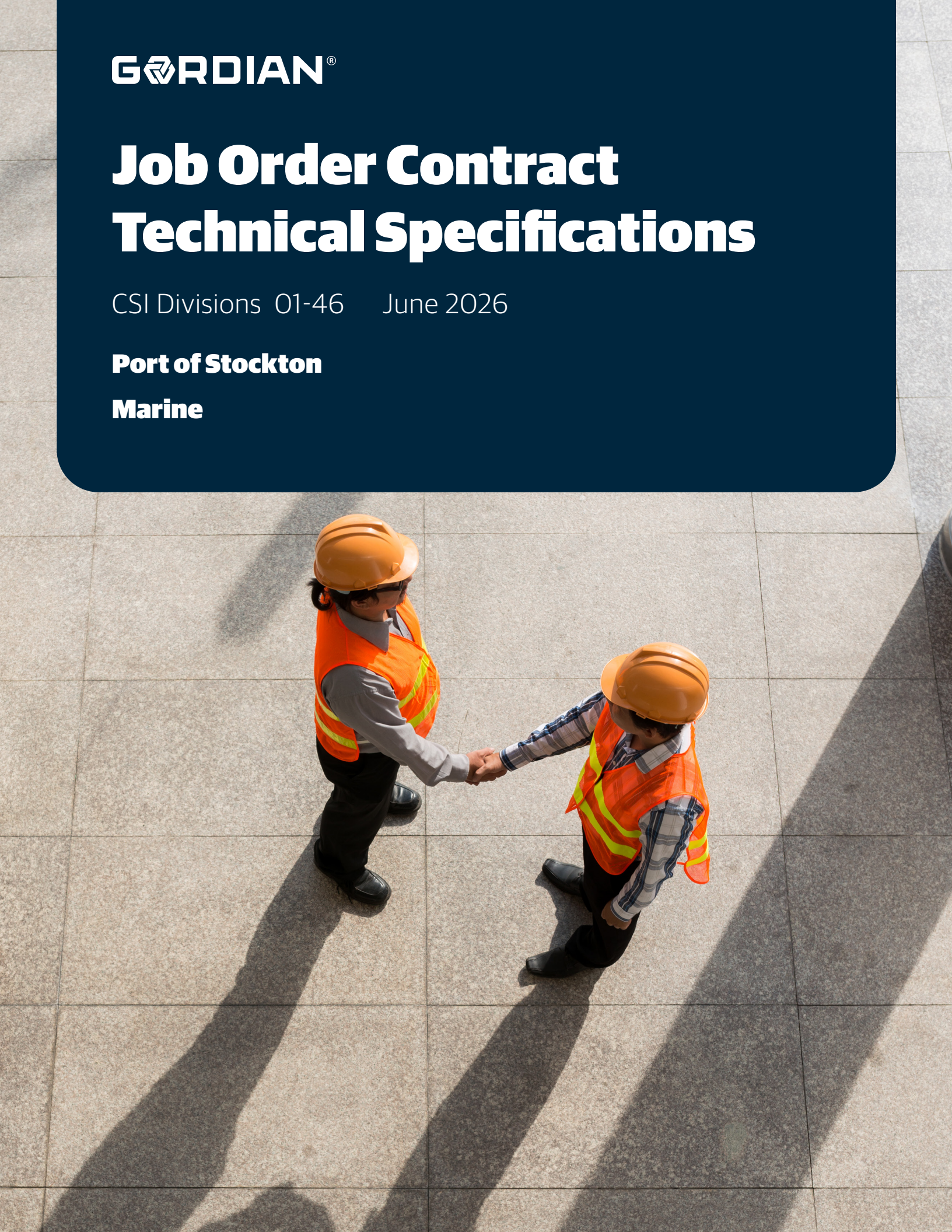
GORDIAN®

Job Order Contract Technical Specifications

CSI Divisions 01-46 June 2026

Port of Stockton

Marine



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SECTION 01 00 00 00 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 BRACKETED OPTIONS

A. Within these Technical Specifications there are bracketed options. For example **[6ft] [12ft] [24ft]** or **<Insert…>**. The final selection will be made by the Owner and set forth in the Detailed Scope of Work.

1.2 WARRANTY

A. Within these Technical Specifications there are warranty periods listed. The warranty periods listed cover both material and labor for that period. If a manufacture will warranty a material for a longer period than what is listed, the material is covered as a replacement by the manufacture for the extra period. The labor to replace will be at the installation price for the contractor.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 00 00 00

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Task	Specification	Specification Description
01 10 00 00	01 00 00 00	General Requirements
01 11 00 00	01 00 00 00	General Requirements

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SECTION 01 11 13 00 - WORK COVERED BY CONTRACT DOCUMENTS

1.1 GENERAL

A. If any conflicts arise in the Specifications; the Owner's Standard Plans and Specifications supersede the Gordian Technical Specifications. Specification conflicts shall be resolved as directed by the Owner.

B. Contractor is to provide a competent person to ensure operations are completed per plans, specifications, local laws and regulations which pertain.

C. Specification Format
   1. The specification format shall be based on the Construction Specifications Institute (CSI) Section Format.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01 11 13 00

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Task	Specification	Specification Description
01 11 13 00	01 00 00 00	General Requirements

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SECTION 01 11 19 00 - NO SPECIFICATION REQUIRED

1.1 GENERAL

A. A separate specification is not required for this item. The description given in the line item of the Construction Task Catalog completely defines the item.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01 11 19 00

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Task	Specification	Specification Description
01 11 19 00	01 00 00 00	General Requirements
01 20 00 00	01 00 00 00	General Requirements
01 22 00 00	01 00 00 00	General Requirements
01 22 00 00	01 11 19 00	No Specification Required
01 22 16 00	01 00 00 00	General Requirements
01 22 16 00	01 11 19 00	No Specification Required
01 22 20 00	01 00 00 00	General Requirements
01 22 20 00	01 11 19 00	No Specification Required
01 22 23 00	01 00 00 00	General Requirements
01 22 23 00	01 11 19 00	No Specification Required
01 30 00 00	01 00 00 00	General Requirements
01 35 00 00	01 00 00 00	General Requirements
01 35 29 00	01 00 00 00	General Requirements
01 35 33 00	01 00 00 00	General Requirements

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SECTION 01 40 00 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner,[**Commissioning Authority,**][**Construction Manager,**] or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Requirements:

1. Section 012100 "Allowances" for testing and inspection allowances.

1.2 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of [**five**] previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.

1. Mockups are used for one or more of the following:

a. Verify selections made under Sample submittals.
b. Demonstrate aesthetic effects.
c. Demonstrate the qualities of products and workmanship.

d. Demonstrate successful installation of interfaces between components and systems.
e. Perform preconstruction testing to determine system performance.

2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect[**or Construction Manager**].

1.3 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.4 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting

requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 ACTION SUBMITTALS

A. Mockup Shop Drawings:

1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
2. Indicate manufacturer and model number of individual components.
3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses,

certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within [**10**] days of [**Notice of Award**][**Notice to Proceed**], and not less than [**five**] days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager [**may also serve as Project superintendent**][**does not have other Project responsibilities**].

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
3. Owner-performed tests and inspections indicated in the Contract Documents[**, including tests and inspections indicated to be performed by Commissioning Authority**].

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.

2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement of whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement of whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.9 QUALITY ASSURANCE

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.

1. Requirements of authorities having jurisdiction supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor's Responsibilities:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
e. When testing is complete, remove test specimens and test assemblies[**, and mockups**]; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect[**and Commissioning Authority**][**, through Construction Manager**], with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups of size indicated.

2. Build mockups in location indicated or, if not indicated, as directed by Architect[**or Construction Manager**].
3. Notify Architect[**and Construction Manager**][**seven**] days in advance of dates and times when mockups will be constructed.
4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.
6. Obtain Architect's[**and Construction Manager's**] approval of mockups before starting corresponding Work, fabrication, or construction.

    a. Allow [**seven**] days for initial review and each re-review of each mockup.

7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
10. Demolish and remove mockups when directed unless otherwise indicated.

L. Specialty Mockups: See Section 014339 "Mockups" for additional construction requirements for [**integrated exterior mockups**][**preconstruction laboratory mockups**][**and**][**room mockups**].

1.10 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Payment for these services will be made from testing and inspection allowances specified in Section 012100 "Allowances," as authorized by Change Orders.
3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor[**, and the Contract Sum will be adjusted by Change Order**].

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.

    a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least [**24**] hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Architect[**, Commissioning Authority**][**, Construction Manager,**] and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect[**, Commissioning Authority,**][**, Construction Manager,**] and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents[**as a component of Contractor's quality-control plan**].

Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.

1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
2. Distribution: Distribute schedule to Owner, Architect,[**Commissioning Authority,**][**Construction Manager,**] testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified [**testing agency**][**special inspector**] to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner[**, as indicated in the Statement of Special Inspections attached to this Section**], and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures, and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect[**, Commissioning Authority,**][**, Construction Manager,**] and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect[**and Commissioning Authority**][**, through Construction Manager,**] with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections, and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's[**, Commissioning Authority's,**][**and Construction Manager's**][**and**][**authorities' having jurisdiction**] reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00 00

Task	Specification	Specification Description
01 40 00 00	01 00 00 00	General Requirements
01 41 00 00	01 00 00 00	General Requirements
01 41 00 00	01 40 00 00	Quality Requirements
01 41 26 00	01 00 00 00	General Requirements
01 41 26 00	01 40 00 00	Quality Requirements

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SECTION 01 42 00 00 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms, including "requested," "authorized," "selected," "required," and "permitted," have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms, including "shown," "noted," "scheduled," and "specified," have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations, List: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. [**Abbreviations and acronyms not included in this list are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."**]The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; (see FGIA).
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; www.concrete.org.
9. ACP - American Clean Power; (Formerly: American Wind Energy Association); www.cleanpower.org.
10. ACPA - American Concrete Pipe Association; www.concretepipe.org.
11. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
12. AF&PA - American Forest & Paper Association; www.afandpa.org.
13. AGA - American Gas Association; www.aga.org.
14. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
15. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
16. AI - Asphalt Institute; www.asphaltinstitute.org.
17. AIA - American Institute of Architects (The); www.aia.org.
18. AISC - American Institute of Steel Construction; www.aisc.org.
19. AISI - American Iron and Steel Institute; www.steel.org.
20. AITC - American Institute of Timber Construction; (see PLIB).
21. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
22. AMPP - Association for Materials Protection and Performance; www.ampp.org.
23. ANSI - American National Standards Institute; www.ansi.org.
24. AOSA/SCST - Association of Official Seed Analysts (The)/Society of Commercial Seed Technologists (The); www.analyzeseeds.com.
25. APA - APA - The Engineered Wood Association; www.apawood.org.
26. APA - Architectural Precast Association; www.archprecast.org.
27. API - American Petroleum Institute; www.api.org.
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASA - Acoustical Society of America; www.acousticalsociety.org.
30. ASCE - American Society of Civil Engineers; www.asce.org.
31. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (see ASCE).
32. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.

33. ASME - ASME International; [**American Society of Mechanical Engineers (The)**]; www.asme.org.
34. ASSE - ASSE International; (American Society of Sanitary Engineering); www.asse-plumbing.org.
35. ASSP - American Society of Safety Professionals; www.assp.org.
36. ASTM - ASTM International; www.astm.org.
37. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
38. AVIXA - Audiovisual and Integrated Experience Association; www.avixa.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - Business and Institutional Furniture Manufacturer's Association; www.bifma.org.
48. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
49. BSI - British Standards Institution; www.bsigroup.com.
50. BWF - Badminton World Federation; www.bwfbadminton.com.
51. CARB - California Air Resources Board; www.arb.ca.gov.
52. CDA - Copper Development Association Inc.; www.copper.org.
53. CE - Conformite Europeenne (European Commission); www.ec.europa.eu/growth/single-market/ce-marking.
54. CEA - Canadian Electricity Association; www.electricity.ca.
55. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
56. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
57. CGA - Compressed Gas Association; www.cganet.com.
58. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
59. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
60. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
61. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
62. CMHA - Concrete Masonry & Hardscape Association; (Formerly: National Concrete Masonry Association); www.masonryandhardscapes.org.
63. CPA - Composite Panel Association; www.compositepanel.org.
64. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
65. CRRC - Cool Roof Rating Council; www.coolroofs.org.
66. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
67. CSA - CSA Group; www.csagroup.org.
68. CSI - Cast Stone Institute; www.caststone.org.
69. CSI - Construction Specifications Institute (The); www.csiresources.org.
70. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
71. CTA - Consumer Technology Association; www.cta.tech.
72. CTI - Cooling Technology Institute; www.coolingtechnology.org.
73. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
74. DHA - Decorative Hardwoods Association; www.decorativehardwoods.org.
75. DHI - Door and Hardware Institute; www.dhi.org.
76. ECIA - Electronic Components Industry Association; www.ecianow.org.
77. EIMA - EIFS Industry Members Association; www.eima.com.
78. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
79. EOS/ESD - EOS/ESD Association, Inc.; Electrostatic Discharge Association; www.esda.org.
80. ESTA - Entertainment Services and Technology Association; www.esta.org.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
83. FGIA - Fenestration and Glazing Industry Alliance; https://fgiaonline.org.
84. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.

85. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
86. FM Approvals - FM Approvals LLC; www.fmapprovals.com.
87. FM Global - FM Global; www.fmglobal.com.
88. FRSA - Florida Roofing and Sheet Metal Contractors Association, Inc.; www.floridaroof.com.
89. FSA - Fluid Sealing Association; www.fluidsealing.com.
90. FSC - Forest Stewardship Council U.S.; www.fscus.org.
91. GA - Gypsum Association; www.gypsum.org.
92. GS - Green Seal; www.greenseal.org.
93. HI - Hydraulic Institute; www.pumps.org.
94. HMMA - Hollow Metal Manufacturers Association; (see NAAMM).
95. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
96. IAS - International Accreditation Service; www.iasonline.org.
97. ICC - International Code Council; www.iccsafe.org.
98. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
99. ICPA - International Cast Polymer Association (The); www.theicpa.com.
100. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
101. IEC - International Electrotechnical Commission; www.iec.ch.
102. IEEE SA - IEEE Standards Association; https://standards.ieee.org.
103. IES - Illuminating Engineering Society; www.ies.org.
104. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
105. IGMA - Insulating Glass Manufacturers Alliance; (see FGIA).
106. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
107. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
108. Intertek - Intertek Group; www.intertek.com.
109. ISA - International Society of Automation (The); www.isa.org.
110. ISFA - International Surface Fabricators Association; www.isfanow.org.
111. ISO - International Organization for Standardization; www.iso.org.
112. ITU - International Telecommunication Union; www.itu.int.
113. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
114. LPI - Lightning Protection Institute; www.lightning.org.
115. MBMA - Metal Building Manufacturers Association; www.mbma.com.
116. MCA - Metal Construction Association; www.metalconstruction.org.
117. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
118. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
119. MHI - Material Handling Industry; www.mhi.org.
120. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
121. MPI - Master Painters Institute; www.paintinfo.com.
122. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.; www.msshq.org.
123. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
124. NACE - NACE International; (National Association of Corrosion Engineers International); (see AMPP).
125. NADCA - National Air Duct Cleaners Association; www.nadca.com.
126. NAIMA - North American Insulation Manufacturers Association; www.insulationinstitute.org.
127. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
128. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
129. NBI - New Buildings Institute; www.newbuildings.org.
130. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
131. NCMA - National Concrete Masonry Association; (see CMHA).
132. NEBB - National Environmental Balancing Bureau; www.nebb.org.
133. NECA - National Electrical Contractors Association; www.necanet.org.
134. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
135. NEMA - National Electrical Manufacturers Association; www.nema.org.
136. NETA - InterNational Electrical Testing Association; www.netaworld.org.

137. NFHS - National Federation of State High School Associations; www.nfhs.org.
138. NFPA - National Fire Protection Association; www.nfpa.org.
139. NFPA - NFPA International; (see NFPA).
140. NFRC - National Fenestration Rating Council; www.nfrc.org.
141. NGA - National Glass Association; www.glass.org.
142. NHLA - National Hardwood Lumber Association; www.nhla.com.
143. NLGA - National Lumber Grades Authority; www.nlga.org.
144. NOFMA - National Oak Flooring Manufacturers Association; (see NWFA).
145. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
146. NRCA - National Roofing Contractors Association; www.nrca.net.
147. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
148. NSF - NSF International; www.nsf.org.
149. NSI - Natural Stone Institute; www.naturalstoneinstitute.org.
150. NSPE - National Society of Professional Engineers; www.nspe.org.
151. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
152. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
153. NWFA - National Wood Flooring Association; www.nwfa.org.
154. NWRA - National Waste & Recycling Association; www.wasterecycling.org.
155. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
156. PDI - Plumbing & Drainage Institute; www.pdionline.org.
157. PLASA - PLASA; www.plasa.org.
158. PLIB - Pacific Lumber Inspection Bureau; www.plib.org.
159. PVCPA - Uni-Bell PVC Pipe Association; www.uni-bell.org.
160. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
161. RFCI - Resilient Floor Covering Institute; www.rfci.com.
162. RIS - Redwood Inspection Service; (see WWPA).
163. SAE - SAE International; www.sae.org.
164. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
165. SDI - Steel Deck Institute; www.sdi.org.
166. SDI - Steel Door Institute; www.steeldoor.org.
167. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
168. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (see ASCE).
169. SIA - Security Industry Association; www.securityindustry.org.
170. SJI - Steel Joist Institute; www.steeljoist.org.
171. SMA - Screen Manufacturers Association; www.smainfo.org.
172. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
173. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
174. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
175. SPIB - Southern Pine Inspection Bureau; www.spib.org.
176. SPRI - Single Ply Roofing Industry; www.spri.org.
177. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
178. SSINA - Specialty Steel Industry of North America; www.ssina.com.
179. SSPC - SSPC: The Society for Protective Coatings; (see AMPP).
180. STI/SPFA - Steel Tank Institute/Steel Plate Fabricators Association; www.steeltank.com.
181. SWI - Steel Window Institute; www.steelwindows.com.
182. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
183. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
184. TCNA - Tile Council of North America, Inc.; www.tcnatile.com.
185. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.kbcdco.tema.org.
186. TIA - Telecommunications Industry Association; www.tiaonline.org.
187. TMS - The Masonry Society; www.masonrysociety.org.
188. TPI - Truss Plate Institute; www.tpinst.org.
189. TPI - Turfgrass Producers International; www.turfgrasssod.org.
190. TRI - Tile Roofing Industry Alliance; www.tileroofing.org.
191. ULSE - UL Standards & Engagement Inc.; www.ulse.org.

192. UL - UL Solutions Inc.; www.ul.com.
193. USAV - USA Volleyball; www.usavolleyball.org.
194. USGBC - U.S. Green Building Council; www.usgbc.org.
195. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
196. WA - Wallcoverings Association; www.wallcoverings.org.
197. WCLIB - West Coast Lumber Inspection Bureau; (see PLIB).
198. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
199. WDMA - Window & Door Manufacturers Association; www.wdma.com.
200. WI - Woodwork Institute; www.woodworkinstitute.com.
201. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
202. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. CPSC - U.S. Consumer Product Safety Commission; www.cpsc.gov.
2. DOC - U.S. Department of Commerce; www.commerce.gov.
3. DOD - U.S. Department of Defense; www.defense.gov.
4. DOE - U.S. Department of Energy; www.energy.gov.
5. DOJ - U.S. Department of Justice; www.ojp.usdoj.gov
6. DOS - U.S. Department of State; www.state.gov.
7. EPA - United States Environmental Protection Agency; www.epa.gov.
8. FAA - Federal Aviation Administration; www.faa.gov.
9. GPO - U.S. Government Publishing Office; www.gpo.gov.
10. GSA - U.S. General Services Administration; www.gsa.gov.
11. HUD - U.S. Department of Housing and Urban Development; www.hud.gov.
12. LBNL - Lawrence Berkeley National Laboratory; Energy Technologies Area; www.lbl.gov/.
13. NIST - National Institute of Standards and Technology; www.nist.gov.
14. OSHA - Occupational Safety & Health Administration; www.osha.gov.
15. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
16. USACE - U.S. Army Corps of Engineers; www.usace.army.mil.
17. USDA - U.S. Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
18. USDA - U.S. Department of Agriculture; Rural Utilities Service; www.usda.gov.
19. USP - U.S. Pharmacopeial Convention; www.usp.org.
20. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from U.S. Government Publishing Office; www.govinfo.gov.

2. DOD - U.S. Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.
3. DSCC - Defense Supply Center Columbus; (see FS).
4. FED-STD - Federal Standard; (see FS).
5. FS - Federal Specification; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.

    a. Available from Defense Standardization Program; www.dsp.dla.mil.
    b. Available from U.S. General Services Administration; www.gsa.gov.
    c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.

6. MILSPEC - Military Specifications and Standards; (see DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (see USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. BEARHFTI; California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; (see BHGS).
2. BHGS; State of California Bureau of Household Goods and Services; (Formerly: California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation); www.bhgs.dca.ca.gov.
3. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.oal.ca.gov/publications/ccr/.
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHLB/IAQ/Pages/Main-Page.aspx.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; https://tfsweb.tamu.edu/.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

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Task	Specification	Specification Description
01 42 00 00	01 00 00 00	General Requirements
01 42 00 00	01 40 00 00	Quality Requirements
01 42 13 00	01 00 00 00	General Requirements
01 42 13 00	01 40 00 00	Quality Requirements
01 42 13 00	01 42 00 00	References
01 42 16 00	01 00 00 00	General Requirements
01 42 16 00	01 40 00 00	Quality Requirements
01 42 16 00	01 42 00 00	References
01 42 19 00	01 00 00 00	General Requirements
01 42 19 00	01 40 00 00	Quality Requirements
01 42 19 00	01 42 00 00	References
01 42 21 00	01 00 00 00	General Requirements
01 42 21 00	01 40 00 00	Quality Requirements
01 42 21 00	01 42 00 00	References
01 45 00 00	01 00 00 00	General Requirements
01 45 00 00	01 40 00 00	Quality Requirements
01 45 23 00	01 00 00 00	General Requirements
01 45 23 00	01 11 19 00	No Specification Required
01 45 23 00	01 40 00 00	Quality Requirements
01 45 29 00	01 00 00 00	General Requirements
01 45 29 00	01 11 19 00	No Specification Required
01 45 29 00	01 40 00 00	Quality Requirements

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SECTION 01 50 00 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.
2. Section 011200 "Multiple Contract Summary" for responsibilities for temporary facilities and controls for projects utilizing multiple contracts.
3. Section 012100 "Allowances" for allowance for metered use of temporary utilities.

1.2 USE CHARGES

A. Installation, removal, and use charges for temporary facilities to be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to,[**Owner's construction forces,**] Architect,[**occupants of Project,**] testing agencies, and authorities having jurisdiction.

B. Sewer Service: [**Pay**][**Owner will pay**] sewer-service use charges for sewer usage by all entities for construction operations.

C. Water Service: [**Pay**][**Owner will pay**] water-service use charges for water used by all entities for construction operations.

D. Electric Power Service: [**Pay**][**Owner will pay**] electric-power-service use charges for electricity used by all entities for construction operations.

E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use [**with metering**][**without metering and without payment of use charges**]. Provide connections and extensions of services [**and metering**] as required for construction operations.

F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use [**with metering**][**without metering and without payment of use charges**]. Provide connections and extensions of services [**and metering**] as required for construction operations.

G. Sewer, Water, and Electric Power Service: Use charges are specified in Section 011200 "Multiple Contract Summary."

1.3 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Implementation and Termination Schedule: Within [**15**] days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility, as

directed by the Owner.

C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.

1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.

F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

G. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by Owner. Include the following:

1. Methods used to meet the goals and requirements of Owner.
2. Concrete cutting method(s) to be used.
3. Location of construction devices on the site.
4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with Owner.
6. Indicate locations of sensitive [**research**][**patient**][**equipment**] areas or other areas requiring special attention as identified by Owner. Indicate means for complying with Owner's requirements.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in [**the DOJ's "2010 ADA Standards**

for Accessible Design"][**and**][**ICC A117.1**].

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chain-Link Fencing: Minimum **2-inch**, **0.148-inch-** thick, galvanized-steel, chain-link fabric fencing; minimum **6 feet** high with galvanized-steel pipe posts; minimum **2-3/8-inch-** OD line posts and **2-7/8-inch-** OD corner and pull posts[**, with 1-5/8-inch- OD top rails**][**, with galvanized barbed-wire top strand**].

B. Portable Chain-Link Fencing: Minimum **2-inch**, **0.148-inch-** thick, galvanized-steel, chain-link fabric fencing; minimum **6 feet** high with galvanized-steel pipe posts; minimum **2-3/8-inch-** OD line posts and **2-7/8-inch-** OD corner and pull posts, with **1-5/8-inch-** OD top and bottom rails. Provide [**concrete**][**galvanized-steel**] bases for supporting posts.

C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.

D. Wood Enclosure Fence: Plywood, [**6 feet**][**8 feet**] high, framed with four **2-by-4-inch** rails, with preservative-treated wood posts spaced not more than **8 feet** apart.

E. Polyethylene Sheet: Reinforced, fire-resistive sheet, **10-mil** minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.

F. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum **36 by 60 inches**.

G. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

A. Field Offices:

1. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
2. Owner will provide conditioned interior space for field offices [**for duration of Project**][**upon completion of demolition and enclosure**].

B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect[**, Construction Manager**], and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents, including file cabinets, plan tables, plan racks, and bookcases.

2. Conference room of sufficient size to accommodate meetings of [**10**] individuals, as directed by the Owner. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and **4-foot-** square tack and marker boards.
3. Drinking water and private toilet.
4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of **68 to 72 deg F**.
5. Lighting fixtures capable of maintaining average illumination of **20 fc** at desk height.

C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Store combustible materials apart from building.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no

longer needed or are replaced by authorized use of completed permanent facilities.

C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed[**in accordance with coordination drawings**].

a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
b. Maintain negative air pressure within work area, using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to [**municipal system**][**private system indicated**] as directed by authorities having jurisdiction.

C. Water Service:

1. Install water service and distribution piping in sizes and pressures adequate for construction.
2. Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities [**is not permitted**][**will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use**].

E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

F. Electric Power Service:

1. Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
2. Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

    a. Install electric power service [**overhead**][**underground**] unless otherwise indicated.
    b. Connect temporary service to Owner's existing power source, as directed by Owner.

G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

H. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install [**WiFi cell phone access equipment**][**and**][**one**] land-based telephone line(s) for each field office, as directed by the Owner.

1. Provide additional telephone lines for the following:

    a. Provide [**one**] telephone line(s) for Owner's use, as directed by the Owner.

2. At each telephone, post a list of important telephone numbers.

    a. Police and fire departments.
    b. Ambulance service.
    c. Contractor's home office.
    d. Contractor's emergency after-hours telephone number.
    e. Architect's office.
    f. [**Construction Manager's home office**].
    g. Engineers' offices.
    h. Owner's office.
    i. Principal subcontractors' field and home offices.

I. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Architect and Owner.

J. Project Computer: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:

1. Processor: Intel Core i5 or i7.
2. Memory: [**16**] gigabyte.
3. Disk Storage: [**1**] -terabyte hard-disk drive and combination DVD-RW/CD-RW drive.
4. Display: **24-inch** LCD monitor with 256-Mb dedicated video RAM.
5. Full-size keyboard and mouse.
6. Network Connectivity: [**10/100BaseT Ethernet**][**Gigabit**].
7. Operating System: Microsoft Windows 10 Professional.
8. Productivity Software:

    a. Microsoft Office Professional, 2013 or higher, including Word, Excel, and Outlook.
    b. Adobe Reader DC.
    c. WinZip 10.0 or higher.

9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
10. Internet Service: Broadband modem, router, and ISP, equipped with hardware firewall, providing minimum [**10.0**] -Mbps upload and [**15**] -Mbps download speeds at each computer, as directed by the Owner.
11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
12. Backup: External hard drive, minimum [**2**] terrabytes, with automated backup software providing daily backups, as directed by the Owner.

3.4 SUPPORT FACILITIES INSTALLATION

A. Comply with the following:

1. Provide construction for temporary field offices, shops, and sheds located within construction area or within **30 feet** of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
2. Utilize designated area within existing building for temporary field offices.
3. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas [**as indicated**][**within construction limits indicated**] on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."

D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Parking: [**Provide temporary offsite**][**Use designated areas of Owner's existing**] parking areas for construction personnel.

F. Storage and Staging: [**Provide temporary offsite area**][**Use designated areas of Project site**] for storage and staging needs.

G. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

H. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

    a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touch up signs, so they are legible at all times.

I. Waste Disposal Facilities:

1. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
2. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

J. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

K. Temporary Elevator Use: [**Use of elevators is not permitted**][**See Division 14 elevator Section for temporary use of new elevators**].

L. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

1. Do not load elevators beyond their rated weight capacity.
2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work, so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

M. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

N. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas, so no evidence remains of correction work.

O. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 011000 "Summary."

C. Temporary Erosion and Sedimentation Control:

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection:

1. Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
2. Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

G. Site Enclosure Fence: [**Before construction operations begin**][**Prior to commencing earthwork**], furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.

1. Extent of Fence: [**As required to enclose entire Project site or portion determined sufficient to accommodate construction operations**][**As indicated on Drawings**].
2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.[**Furnish one set of keys to Owner.**]

H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

J. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.

K. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction[**and requirements indicated on Drawings**].

1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
2. Paint and maintain appearance of walkway for duration of the Work.

L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

M. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by [**Owner**][**and**][**tenants**] from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard, with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
2. Construct dustproof partitions with two layers of **6-mil** polyethylene sheet on each side. Cover floor with two layers of **6-mil** polyethylene sheet, extending sheets **18 inches** up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.

    a. Construct vestibule and airlock at each entrance through temporary partition with not less than **48 inches** between doors. Maintain water-dampened foot mats in vestibule.

3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
4. Insulate partitions to control noise transmission to occupied areas.
5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
6. Protect air-handling equipment.
7. Provide walk-off mats at each entrance through temporary partition.

N. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture

and Mold Protection Plan.

B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Periodically collect and remove waste containing cellulose or other organic matter.
4. Discard or replace water-damaged material.
5. Do not install material that is wet.
6. Discard and replace stored or installed material that begins to grow mold.
7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

    a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for [**48**] hours are considered defective and require replacing.
    b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for [**48**] hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
    c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within [**48**] hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 01 50 00 00

Task	Specification	Specification Description
01 50 00 00	01 00 00 00	General Requirements
01 51 00 00	01 00 00 00	General Requirements

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SECTION 01 51 13 00 - TEMPORARY ELECTRICITY

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for electrical renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Quality Assurance
   1. Regulatory Requirements: Comply with following:
      a. Electrical: National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code (NEC).
      b. Accessibility:
         1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
            a) Uniform Federal Accessibility Standards (UFAS).
         2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
         3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
         4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).

B. Project Conditions
   1. Existing Conditions: Buildings will be occupied during construction. See Division 1 Section “Summary of Work.” Do not interfere with use of occupied portions of building. Maintain free and safe passage to and from occupied areas.

C. Scheduling And Sequencing
   1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

D. Alterations, Cutting And Protection
   1. Protection: Protect existing finishes, equipment, utilities and adjacent work, which is scheduled to remain, from damage.
   2. Existing Operating Facilities: Confine operations to immediate vicinity of new work and do not interfere with or obstruct ingress or egress to and from adjacent facilities.

1.3 PRODUCTS

A. Materials
   1. Electrical Materials and Devices: Comply with NFPA 70 (NEC):
      a. Boxes: Galvanized steel, not less than 1.6 mm (0.0625 inch) thickness (NEC 370-20) grounded in accordance with NEC, Article 250, suitable for recess mounting.
         1) Provide boxes of appropriate shape and size for intended purpose.
      b. Devices:
         1) Duplex Receptacles: 15 A or 20 A 115 V, UL Listed with screw side connections and corrugated bearing pads.
            a) GFIC Outlets: 115 V, 60 Hz, 15/20 A rating, UL Listed.
         2) Switches: 15 A. 115 V, single pole, single throw switch, UL Listed, with side screw connections and corrugated bearing pads.

a) Garbage Disposal: Heavy duty, 120/277 VAC, 60 Hz, single pole, single throw, 20 A rate, UL listed and CSA certified.

3) Cover Plates: Smooth plastic in color to match existing.

c. Wiring: Insulated wire, Type NM 600 V with ground wire, sized as appropriate for intended purpose and in accordance with NEC.

1) Aluminum Wire: Not allowed unless existing wiring is aluminum.

2) Provide necessary fittings in accordance with NEC.

1.4 EXECUTION

A. Examination

1. Units, Spaces and Areas to be Renovated: Inspect to become familiar with existing conditions and to take measurements which are necessary for renovation work to be completed in accordance with contract requirements.
   a. Carefully inspect condition of existing spaces including, but not limited to walls, floors, plumbing, electrical, etc. as essential to successful completion of renovation work.
   b. Survey each space and verify dimensions for work.

B. Preparation

1. Building Occupation: Carry out renovation work to cause as little inconvenience to occupants as possible. See Division 1 Section “Summary of Work.”
2. Protection: Protect and be responsible for existing buildings, facilities, utilities, and improvements within areas of construction operations.
   a. Tenant's Property: Be responsible for any damage or loss to residents' property and to other work. Replace any material, which, in opinion of the Owner, has become damaged to extent that it could not be restored to its original condition.
   b. Take precautions to protect residents and public from injury from construction operations.

C. Laying Out Work

1. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
   a. Prior to commencing work, carefully compare and check Drawings (if any), for discrepancies in locations or elevations of work to be executed.
   b. Refer discrepancies among Drawings (if any), Specifications and existing conditions to the Owner for adjustment before work affected is performed.
      1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
2. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

D. Location Of Equipment And Piping

1. Drawings (if any) indicating location of equipment, piping, ductwork, etc. are diagrammatic and job conditions shall not always permit their installation in location shown. When this situation occurs, bring condition to the Owner's attention immediately. Relocation will be determined in joint conference.
2. Contractor: Do not relocate any items without first obtaining the Owner's acceptance. Remove and relocate such relocated items at own expense if so directed.

E. Electrical Work

1. General: Install boxes, wiring, and devices as indicated and required to connect and control electrical devices in accordance with NFPA 70 (NEC).
   a. Boxes: Solidly anchor to framing or blocking.
2. Removing Electrical Switch or Duplex Outlet (Non-Hazardous Locations):
   a. Box to Remain:
      1) Remove electrical device; cap hot and neutral with set-screw wire connectors.

2) Attach ground wire to remaining box with solid screw attachment.
3) Provide and install natural finish aluminum blank cover plate with screw fasteners integral to match size of box remaining.

b. Box to be removed:
1) Remove electrical device and box and pull wire out of wall back to first circuit panel, disconnecting from circuit panel.
2) Patch and repair hole in partition to match existing.

3. Garbage Disposal Electrical Hook-up: See Section “Plumbing.” Comply with NFPA 70 (NEC):
a. Wiring: Install from disposal through concealed spaces to house panel, anchoring wire, and providing necessary fittings.
b. Switch: Install above counter top backsplash.

4. Range Hood Electrical Hook-up: See Section “Residential Appliances.” Comply with NFPA 70 (NEC):
a. Electric service: Install insulated wire from range hood through concealed spaces to house panel, anchoring wire, and providing necessary fittings.

5. Water Heater Electrical Hook-up: See Division 15 Section “Domestic Water Heaters.” Comply with NFPA 70 (NEC).

6. Furnace Electrical Hook-up: See Section “Furnaces.” Comply with NFPA 70 (NEC).

7. Smoke Detector Electrical Hook-up: See “Fire Alarm.” Comply with NFPA 70 (NEC).

F. Integrating Existing Work
1. Protection: Protect existing improvements from damage.
a. Where new work is to be connected to existing work, exercise special care not to disturb or damage existing work more than necessary.
b. Damaged Work: Replace, repair and restored to its original condition at no cost to the Owner.

END OF SECTION 01 51 13 00

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SECTION 01 51 13 00A - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panelboards.
2. Disconnecting and overcurrent protective devices.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**> .

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
7. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, and arc-flash hazard analysis studies.
8. Section 260913 "Electrical Power Monitoring" specifies power monitoring and control systems installed by this Section.
9. Section 262813 "Fuses" specifies fuses and spare-fuse cabinets installed by this Section.
10. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies Type 1 and Type 2 surge protective devices installed by this Section.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. SPD: Surge protective device.

C. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.
3. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.
4. Include manufacturer's sample extended warranty language.

B. Shop Drawings: For each panelboard and related equipment.

1. Include plans, elevations, sections, details, and attachments to other Work.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field Quality Control Reports: For specified tests and inspections.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. [**Submit final versions after load balancing.**]

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.
3. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.7 QUALIFICATIONS

A. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with [**NECA 407**][**NEMA PB 1**] .

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials [**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**] , freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**> .

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**> .

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**> .

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**> .

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**> .

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**> .

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces specified in Section 018123 "Facility Seismic and Wind Criteria."

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Comply with NEMA PB 1.

E. Enclosures: [**Flush**][**and**][**Surface**] -mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: UL 50E, [**Type 1**]<**Insert type**> .
b. Outdoor Locations: UL 50E, [**Type 3R**]<**Insert type**> .
c. Kitchen and Wash-Down Areas: UL 50E, [**Type 4X**]<**Insert type**> , [**stainless steel**]<**Insert material**> .
d. Other Wet or Damp Indoor Locations: UL 50E, [**Type 4**]<**Insert type**> .
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, [**Type 5**][**Type 12**] .

2. Height: **7 ft (2.13 m)** maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

    a. Panels and Trim: [**Steel**][**and**][**galvanized steel**] , factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: [**Galvanized steel**][**Same finish as panels and trim**] .
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

F. Phase, Neutral, and Ground Buses:

1. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**] .

    a. Plating must run entire length of bus.
    b. Bus must be fully rated for entire length.

2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**] .
2. Terminations must allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: [**Compression**][**Mechanical**] type, with lug on neutral bar for each pole in panelboard.
5. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type, with lug on bar for each pole in panelboard.

H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: [**5**][**10**][**20**]<**Insert number**> percent.

J. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction. Include label or manual with size and type of allowable upstream and branch devices listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series-connected short-circuit rating.

    a. Panelboards rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
    b. Panelboards rated above 240 V and less than 600 V must have short-circuit ratings as

shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

    a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
    b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.4 PANELBOARDS

A. UL QEUY - Distribution Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ABB Electrification Installations Products**]
    b. [**Eaton**]
    c. [**ESL Power Systems, Inc.**]
    d. [**Mersen USA**]
    e. [**Siemens Industry, Inc., Energy Management Division**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB Electrification Installations Products**]
    b. [**Eaton**]
    c. [**ESL Power Systems, Inc.**]
    d. [**Mersen USA**]
    e. [**Siemens Industry, Inc., Energy Management Division**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Distribution Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

    a. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

        1) For doors more than [**36 inch (914 mm)**]<**Insert dimension**> high, provide two latches, keyed alike.

b. Mains: [**Circuit breaker**][**Fused switch**][**Lugs only**] .

1) Location: [**Top**][**Bottom**][**Convertible between top and bottom**] .
2) Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

c. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: [**Plug-in circuit breakers**][**Bolt-on circuit breakers**][**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**] .
d. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: [**Bolt-on circuit breakers**][**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**] .
e. Branch Overcurrent Protective Devices: Fused switches.

6. Other Available Features Required by Project:

a. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD [**Type 1**][**Type 2**] .
b. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
c. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
d. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
e. Do not mount neutral bus in gutter.
f. Feed-Through Lugs: [**Compression**][**Mechanical**] type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
g. Subfeed (Double) Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
h. Gutter-Tap Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
i. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
j. Split Bus: Vertical buses divided into individual vertical sections.

1) Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**][**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

a) Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
b) External Control-Power Source: [**120 V branch circuit**][**24 V control circuit**]<**Insert requirement**> .

B. UL QEUY - Lighting and Appliance Branch-Circuit Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]

b. [**Bender Inc.; Bender GmbH & Co. KG**]
c. [**Eaton**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**Bender Inc.; Bender GmbH & Co. KG**]
c. [**Eaton**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Lighting and Appliance Branch-Circuit Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

a. Mains: [**Circuit breaker**][**or**][**lugs only**] .

1) Location: [**Top**][**Bottom**][**Convertible between top and bottom**] .
2) Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

b. Branch Overcurrent Protective Devices: [**Plug-in**][**Bolt-on**] circuit breakers, replaceable without disturbing adjacent units.

6. Other Available Features Required by Project:

a. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD [**Type 1**][**Type 2**] .
b. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
c. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
d. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
e. Do not mount neutral bus in gutter.
f. Feed-Through Lugs: [**Compression**][**Mechanical**] type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
g. Subfeed (Double) Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
h. Gutter-Tap Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor

material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

i. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

j. Split Bus: Vertical buses divided into individual vertical sections.

1) Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**][**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

a) Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

b) External Control-Power Source: [**120 V branch circuit**][**24 V control circuit**]<**Insert requirement**> .

k. Doors: Door-in-door construction with concealed hinges; secured with [**flush**][**or**][**multipoint**] latch with tumbler lock; keyed alike. [**Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.**]

l. Column-Type Panelboards: Single row of overcurrent devices [**with narrow gutter extension**][**and**][**overhead junction box equipped with ground and neutral terminal buses**] .

1) Column-Type Panelboard Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

C. UL QEUY - Electronic-Grade Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Electronic-Grade Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

    a. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
    b. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
    c. Factory-Installed, Integral SPD:

        1) Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than [**100 kA**]<**Insert value**> . Peak surge current rating must be arithmetic sum of ratings of individual MOVs in given mode.
        2) Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits may not exceed the following:

            a) Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
            b) Line to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
            c) Neutral to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
            d) Line to Line: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**] .

        3) Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits may not exceed the following:

            a) Line to Neutral: 700 V.
            b) Line to Ground: 700 V.
            c) Neutral to Ground: 700 V.
            d) Line to Line: 1200 V.

        4) SCCR: Equal to [**SCCR of panelboard in which installed**][**or exceed 100 kA**][**or exceed 200 kA**][**or exceed**]<**Insert value**> .
        5) Inominal Rating: [**20 kA**][**10 kA**] .

    d. Buses:

        1) Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
        2) Copper equipment and isolated ground buses.

    e. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. UL QEUY - Load Center :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ABB Electrification Installations Products**]
    b. [**Eaton**]
    c. [**Siemens Industry, Inc., Energy Management Division**]
    d. [**Square D; Schneider Electric USA**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB Electrification Installations Products**]
    b. [**Eaton**]

c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Electronic-Grade Type Panelboards: UL CCN QEUY; including UL 67.

5. Standard Features:

   a. Mains: [**Circuit breaker**][**or**][**lugs only**] .
   b. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
   c. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
   d. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**ABB Electrification Installations Products**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB Electrification Installations Products**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. MCCB: Comply with UL 489, with [**series-connected rating**][**interrupting capacity**] to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

   a. RMS sensing.
   b. Field-replaceable rating plug or electronic trip.

c. Digital display of settings, trip targets, and indicated metering displays.
d. Multi-button keypad to access programmable functions and monitored data.
e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
f. Integral test jack for connection to portable test set or laptop computer.
g. Field-Adjustable Settings:

1) Instantaneous trip.
2) Long- and short-time pickup levels.
3) Long- and short-time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
6. GFPE Circuit Breakers: Class B ground-fault protection (30 mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: [**Compression**][**Mechanical**] style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system.
h. Shunt Trip: [**120 V**][**24 V**]<**Insert voltage**> trip coil energized from separate circuit, set to trip at [**55**][**75**] percent of rated voltage.
i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [**on**][**off**][**on or off**] position.
j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
k. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [**without intentional**][**with field-adjustable 0.1- to 0.6-second**] time delay.
l. Rating Plugs: Three-pole breakers with ampere ratings greater than [**150**]<**Insert value**> A must have interchangeable rating plugs or electronic adjustable trip units.
m. Auxiliary Contacts: [**One, SPDT switch**][**Two, SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
n. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
o. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
p. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
q. Multipole units enclosed in [**single housing with single handle**][**or**][**factory assembled to operate as single unit**] .

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Provide fuses and spare fuse cabinet.
2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with manual interlock override, to prevent opening of cover when switch is in on position. Interlock must prevent switch from being turned on with cover open. Operating handle must have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: [**One**][**Two**] normally open and normally closed contact(s) that operate with switch handle operation.

2.6 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Keys: [**Two**]<**Insert number**> spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFPE Types: [**Two**]<**Insert number**> spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
2. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with [**NECA 407**][**NEMA PB 1.1**] .

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PANELBOARDS

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with [**NECA 407**][**NEMA PB 1.1**] .
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting:

   a. Install floor-mounted panelboards on cast-in-place concrete equipment base(s).
   b. Attach panelboard to vertical finished or structural surface behind panelboard.
   c. Mount surface-mounted panelboards to steel slotted supports [**5/8 inch (16 mm)**][**1-1/4 inch (32 mm)**] in depth. Orient steel slotted supports vertically.
   d. Provide seismic control devices.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Provide mounting and anchoring devices.
4. Mount top of trim [**7.5 ft (2.3 m)**]<**Insert height**> above finished floor unless otherwise indicated.
5. Mount panelboard cabinet plumb and rigid without distortion of box.
6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.

   a. Set field-adjustable, circuit-breaker trip ranges.
   b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
9. Install filler plates in unused spaces.
10. Stub four **1 inch (25 mm)** empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four **1 inch (25 mm)** empty conduits into raised floor space or below slab not on grade.
11. Arrange conductors in gutters into groups and bundle and wrap with wire ties [**after completing load balancing**] .
12. Mount spare fuse cabinet in accessible location.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Install warning signs.

C. Panelboard Nameplates: Label each panelboard with nameplate.

D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in [**transparent card holder**][**metal frame with transparent protective cover**] .

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads [**after balancing panelboard loads**] ; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**> .

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers [**and low-voltage surge arrestors**] stated in NETA ATS, Paragraph 7.6 Circuit Breakers [**and Paragraph 7.19.1 Surge Arrestors, Low-Voltage**] . [**Do not perform**][**Perform**] optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

1. Include certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended in writing by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 01 51 13 00A

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Task	Specification	Specification Description
01 51 13 00	01 00 00 00	General Requirements
01 51 26 00	01 00 00 00	General Requirements
01 52 00 00	01 00 00 00	General Requirements
01 52 13 00	01 00 00 00	General Requirements
01 52 13 00	01 11 19 00	No Specification Required
01 52 13 00	01 50 00 00	Temporary Facilities and Controls
01 52 19 00	01 00 00 00	General Requirements
01 52 19 00	01 50 00 00	Temporary Facilities and Controls
01 53 00 00	01 00 00 00	General Requirements
01 53 16 00	01 00 00 00	General Requirements
01 53 16 00	01 11 19 00	No Specification Required
01 53 23 00	01 00 00 00	General Requirements
01 54 00 00	01 00 00 00	General Requirements

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SECTION 01 54 23 00 - TEMPORARY SCAFFOLDING AND PLATFORMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of scaffolding-tubular steel. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Tubular steel or aluminum scaffolding system shall comply with OSHA Safety and Health Standards, Section 29 CFR, 1926/1910.

1.3 EXECUTION - (Section not used.)

END OF SECTION 01 54 23 00

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Task	Specification	Specification Description
01 54 23 00	01 00 00 00	General Requirements
01 54 23 00	01 11 19 00	No Specification Required
01 54 23 00	04 20 00 00	Unit Masonry
01 54 26 00	01 00 00 00	General Requirements
01 54 26 00	01 11 19 00	No Specification Required
01 55 00 00	01 00 00 00	General Requirements
01 55 23 00	01 00 00 00	General Requirements
01 55 23 00	01 11 19 00	No Specification Required
01 55 26 00	01 00 00 00	General Requirements
01 55 26 00	01 11 19 00	No Specification Required
01 56 00 00	01 00 00 00	General Requirements
01 56 16 00	01 00 00 00	General Requirements
01 56 16 00	01 11 19 00	No Specification Required
01 56 26 00	01 00 00 00	General Requirements
01 56 26 00	01 11 19 00	No Specification Required
01 56 29 00	01 00 00 00	General Requirements
01 56 29 00	01 11 19 00	No Specification Required
01 56 33 00	01 00 00 00	General Requirements
01 56 33 00	01 11 19 00	No Specification Required

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SECTION 01 56 39 00 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes: General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary controls, utilities, support facilities, temporary site fencing, and, if applicable, temporary erosion and sedimentation controls if not specified in Section 311000 "Site Clearing".
2. Section 311000 "Site Clearing" for removing existing trees and shrubs and for temporary erosion- and sedimentation-control measures if not specified in Section 015000 "Temporary Facilities and Controls".
3. Section 329600 "Transplanting" for relocating existing trees and plants.

1.2 DEFINITIONS

A. Caliper: Diameter of a trunk measured by [**a diameter tape**][**or**][**the average of the smallest and largest diameters**] at a height **6 inches** above the ground for trees up to and including **4-inch** size at this height and as measured at a height of **12 inches** above the ground for trees larger than **4-inch** size.

B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by [**a diameter tape**][**or**][**the average of the smallest and largest diameters**] at a height **54 inches** above the ground line[**for trees with caliper of 8 inches or greater as measured at a height of 12 inches above the ground**].

C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and [**indicated on Drawings**][**defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated**][**defined by a circle concentric with each tree with a radius 12 times the tree's caliper size and with a minimum radius of 96 inches unless otherwise indicated**]<**Insert requirement**>.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] as directed by the Owner.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

a. Tree-service firm's personnel and equipment needed to make progress and avoid delays.
b. Arborist's responsibilities.

c. Quality-control program.
d. Coordination of Work and equipment movement with the locations of protection zones.
e. Trenching by hand or with air spade within protection zones.
f. Field quality control.
g. <**Insert agenda items**>.

1.4 ACTION SUBMITTALS

A. Product Data:

1. General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction

B. Shop Drawings:

1. Include plans, elevations, and sections showing trees and plants to be protected, locations of protection-zone fencing and signage, and the relationship between equipment-movement routes and material storage locations with protection zones.
2. Detail fabrication and assembly of protection-zone fencing and signage.
3. Indicate extent of utility boring and trenching by hand or with air spade within protection zones.
4. Include existing irrigation system that will be used to water plants.

C. Samples: For each type of the following:

1. Organic Mulch: [**1-pint**][**1-quart**] volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
2. Protection-Zone Fencing: Assembled Samples of [**manufacturer's standard size made from full-size components**], as directed by the Owner.
3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

D. Tree-Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

E. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

F. Mitigation Requirements: As required by jurisdiction or as developed by arborist, for mitigation of damage to trees and other plantings.[**Include the following:**]

1. Local ordinances governing tree mitigation.
2. Standards established under the approved tree mitigation report developed by the arborist.
3. "Digital Guide for Plant Appraisal" by Council of Tree and Landscape Appraisers.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For arborist and tree service firm.

B. Certification: From arborist, certifying that trees indicated to remain have been protected during construction in accordance with recognized standards and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality-control program.

1.6 QUALITY ASSURANCE

A. Arborist Qualifications: [**Certified Arborist as certified by ISA**][**Board Certified Master Arborist as certified by ISA**][**Certified Arborist-Municipal Specialist as certified by ISA**][**Licensed arborist in jurisdiction where Project is located**][**Current member of ASCA**][**Registered Consulting Arborist as designated by ASCA**].

B. Tree-Service Firm Qualifications: An experienced tree-service firm that has successfully completed temporary tree- and plant-protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

C. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Include dimensioned diagrams for placement of protection-zone fencing and signage, the arborist's and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

1.7 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Moving or parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

D. Take precautions to protect plants from airborne contaminants, such as paint or fireproofing overspray.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill Soil: [**Stockpiled soil from location indicated on Drawings**][**Stockpiled soil mixed with planting soil**][**Planting soil**] of suitable moisture content and granular texture for placing around tree; free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

1. Mixture: Well-blended mix of [**2 parts stockpiled soil to 1 part planting soil**].
2. Planting Soil: Planting soil <**Insert drawing designation**> as specified in [**Section 329113 "Soil Preparation"**][**Section 329115 "Soil Preparation (Performance Specification)."**]

B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: [**Shredded hardwood**][**Ground or shredded bark**][**Wood and bark chips**].
2. Size Range: [**3 inches maximum, 1/2 inch minimum**].
3. Color: Natural.

C. Protection-Zone Fencing: Fencing fixed in position and meeting[**one of**] the following requirements:[**Previously used materials,** as directed by the Owner]

1. Chain-Link Protection-Zone Fencing: [**Galvanized-steel**][**Polymer-coated steel**][**Polymer-coated galvanized-steel**] fencing fabricated from minimum **2-inch** opening, **0.148-inch-** diameter wire chain-link fabric; with pipe posts, minimum **2-3/8-inch-** OD line posts, and **2-7/8-inch-** OD corner and pull posts[**; with 1-5/8-inch- OD top rails**][**; with 0.177-inch- diameter top tension wire**] and **0.177-inch-** diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

   a. Height: [**48 inches**][**72 inches**][**96 inches**].
   b. Polymer-Coating Color: [**Dark green**][**Olive green**][**Brown**][**Black**].

2. Plywood Protection-Zone Fencing: Plywood framed with four **2-by-4-inch** rails, with [**4-by-4-inch**] preservative-treated wood posts spaced not more than **96 inches** apart.

   a. Height: [**48 inches**][**72 inches**].
   b. Plywood and Lumber: Comply with requirements in Section 061000 "Rough Carpentry."

3. Wood Protection-Zone Fencing: Constructed of two **2-by-4-inch** horizontal rails, with [**4-by-4-inch**]<**Insert dimensions**> preservative-treated wood posts spaced not more than **96 inches** apart, and lower rail set halfway between top rail and ground.

   a. Height: [**48 inches**].
   b. Lumber: Comply with requirements in Section 061000 "Rough Carpentry."

4. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with **2-inch** maximum opening in pattern and weighing a minimum of **0.4 lb/ft.**; remaining flexible from **minus 60 to plus 200 deg F**; inert to most chemicals and acids; minimum tensile yield strength of **2000 psi** and ultimate tensile strength of **2680 psi**; secured with plastic bands or galvanized-steel or stainless steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than **96 inches** apart.

a. Height: [48 inches].
b. Color: High-visibility orange, nonfading.

5. Gates: [**Single-**][**Double-**] swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width [**24 inches**][**36 inches**][**As indicated**].

D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: [**As indicated on Drawings**].
2. Lettering: [**3-inch-**] high minimum, [**white**][**black**] characters on [**white**][**red**] background.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain[**or to be relocated**]. [**Flag**][**Tie a 1-inch blue vinyl tape around**] each tree trunk at **54 inches** above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3.3 TREE PROTECTION

A. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply [**2-inch**][**4-inch**] uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within [**6 inches**] of tree trunks.
2. Install temporary root-protection matting over mulch to the extent indicated.

B. Trunk Protection: Protect the trunk of each tree to remain as follows:

1. Install [**2-by-4-inch**][**2-by-6-inch**] wood planks around trunk at maximum **3 inches** apart. Minimum three planks per tree. Band together with no less than three steel bands stapled to the planks to hold them securely in place. [**Wrap orange plastic construction fencing to a minimum of three layers outside slats. Fasten wrap with wire.**]

a. Height: [**48 inches**][**96 inches**][**12 inches from lowest branch**].

2. Wrap trunk with [**orange plastic construction fencing to 2 inches in thickness**][**minimum 1/4-**

inch **closed-cell foam pads**]. Install [**2-by-4-inch**][**2-by-6-inch**] wood planks around trunk over wrap at maximum **3 inches** apart. Minimum three planks per tree. Band together with no less than three steel bands stapled to the planks to hold them securely in place.

a. Height: [**48 inches**][**96 inches**][**12 inches from lowest branch**].
b. Trunk protection to remain in place no longer than [**six months**][**12 months**]. If construction exceeds timeframe indicated, inspect trunk protection at [**six-month**][**12-month**] intervals and loosen if necessary.

3.4 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones[**before materials or equipment are brought on the site and construction operations begin**] in a manner that will prevent people[**and animals**] from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Chain-Link Fencing: Install to comply with ASTM F567 and with manufacturer's written instructions.
2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to the Owner.
3. Access Gates: Install[**where indicated**]; adjust to operate smoothly, easily, and quietly; free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
4. Plastic Fencing: Stretch fabric taut and secure to posts without bows or sags.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner as directed by the Owner. Install one sign spaced approximately every [**20 ft.**][**35 ft.**][**50 ft.**] on protection-zone fencing, but no fewer than [**four**] signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain hydration of plants to assure plant survival.

E. Maintain protection-zone fencing and signage in good condition as directed by the Owner and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.5 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones in accordance with requirements in Section 312000 "Earth Moving" unless otherwise indicated.

B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring,

or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.

3.6 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots [**as indicated on Drawings**][**.**][**and**][**as follows:**]

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends.
3. Temporarily support and protect roots from damage until they are permanently covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible in accordance with requirements in Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune tree roots [**12 inches outside**][**12 inches inside**][**6 inches outside**][**6 inches inside**][**flush with the edge**] of the protection zone by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.7 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches [**as indicated on Drawings, under direction of arborist**][**as directed by arborist**].

1. Prune to remove only[**injured,**] broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
3. Pruning Standards: Prune trees in accordance with ANSI A300 (Part 1)[**and as indicated on Drawings**].

    a. Type of Pruning: [**Cleaning**][**raising**][**reducing**][**and**][**thinning**] where indicated.
    b. Specialty Pruning: [**Structural**][**restoration**][**vista**][**espalier**][**pollarding**][**palm**][**and**][**utility**] where indicated.

B. Unless otherwise directed by arborist and as directed by the Owner, do not cut tree leaders.

C. Cut branches with sharp pruning instruments; do not break or chop.

D. Do not paint or apply sealants to wounds.

E. Provide subsequent maintenance pruning during Contract period as recommended by arborist.

F. Chip removed branches and [**spread over areas as directed by the Owner**][**stockpile in areas as directed by the Owner**][**dispose of off-site**].

3.8 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is [**2 inches**] or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.9 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.10 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner **as directed by the Owner**.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours in accordance with arborist's written instructions.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, **as directed by the Owner**.

B. Trees: Remove and replace trees indicated to remain that are more than [**25**][**66**] percent dead or in an unhealthy condition[**before the end of the corrections period**] or are damaged during construction operations that the Owner determines are incapable of restoring to normal growth pattern.

1. Small Trees: Provide new trees of same size and species as those being replaced for each tree that measures [**6 inches**][**4 inches**] or smaller in caliper size.
2. Large Trees: Provide [**one**][**two**] new tree(s) of [**6-inch**][**4-inch**] caliper size for each tree being replaced that measures more than [**6 inches**][**4 inches**] in caliper size.

a. Species: as directed by the Owner.

3. Plant and maintain new trees as specified in Section 329300 "Plants."

C. Soil Aeration: as directed by the Owner, aerate surface soil compacted during construction. Aerate [**10 ft.**] beyond drip line and no closer than [**36 inches**] to tree trunk. Drill [**2-inch-**] diameter holes a minimum of **12 inches** deep at [**24 inches**] o.c. Backfill holes with an equal mix of augered soil and sand.

END OF SECTION 01 56 39 00

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Task	Specification	Specification Description
01 56 39 00	01 00 00 00	General Requirements
01 56 39 00	01 11 19 00	No Specification Required
01 57 00 00	01 00 00 00	General Requirements
01 57 13 00	01 00 00 00	General Requirements

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SECTION 01 57 23 00 - TEMPORARY STORM WATER POLLUTION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Temporary stormwater pollution controls.

1.2 STORMWATER POLLUTION PREVENTION PLAN

A. The Stormwater Pollution Prevention Plan (SWPPP) is part of the Contract Documents and is bound into this Project Manual.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Meet with Owner, Architect,[**Construction Manager,**] and earthwork subcontractor, as directed by the Owner.
2. Review requirements of the SWPPP, including permitting process, worker training, and inspection and maintenance requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Stormwater Pollution Prevention Plan (SWPP): Within [**15**] days of date established for commencement of the Work, submit completed SWPPP.

B. EPA authorization under the EPA's "2017 Construction General Permit (CGP)."

C. Stormwater Pollution Prevention (SWPP) Training Log: For each individual performing Work under the SWPPP.

D. Inspection reports.

1.5 QUALITY ASSURANCE

A. Stormwater Pollution Prevention Plan (SWPPP) Coordinator: Experienced individual or firm with a record of successful water pollution control management coordination of projects with similar requirements.

1. SWPPP Coordinator shall complete and finalize the SWPPP form.
2. SWPPP Coordinator shall be responsible for inspections and maintaining of all requirements of the SWPPP.

B. Installers: Trained as indicated in the SWPPP.

PART 2 - PRODUCTS

2.1 TEMPORARY STORMWATER POLLUTION CONTROLS

A. Provide temporary stormwater pollution controls as required by the SWPPP.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with all best management practices, general requirements, performance requirements, reporting requirements, and all other requirements included in the SWPPP.

B. Locate stormwater pollution controls in accordance with the SWPPP.

C. Conduct construction as required to comply with the SWPPP and that minimize possible contamination or pollution or other undesirable effects.

1. Inspect, repair, and maintain SWPPP controls during construction.

a. Inspect all SWPPP controls not less than every seven days, and after each occurrence of a storm event, as outlined in the SWPPP.

D. Remove SWPPP controls at completion of construction and restore and stabilize areas disturbed during construction.

END OF SECTION 01 57 23 00

Task	Specification	Specification Description
01 57 23 00	01 00 00 00	General Requirements
01 58 00 00	01 00 00 00	General Requirements
01 58 13 00	01 00 00 00	General Requirements
01 58 13 00	01 11 19 00	No Specification Required

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SECTION 01 60 00 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of This Section Includes: Administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. Section 011000 "Summary" for Contractor requirements related to Owner-furnished products.
2. Section 012100 "Allowances" for products selected under an allowance.
3. Section 012300 "Alternates" for products selected under an alternate.
4. Section 012500 "Substitution Procedures" for requests for substitutions.
5. Section 014200 "References" for applicable industry standards for products specified.
6. Section 017700 "Closeout Procedures" for submitting warranties.

1.2 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products unless otherwise indicated.
3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluating Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.[**Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.**]

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products

qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:

1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
2. Data indicating compliance with the requirements specified in "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."

F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.3 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Resolution of Compatibility Disputes between Multiple Contractors:

a. Contractors are responsible for providing products and construction methods compatible with products and construction methods of other contractors.
b. If a dispute arises between the multiple contractors over concurrently selectable but incompatible products, Architect will determine which products will be used.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is inconspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

a. Name of product and manufacturer.
b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

1.4 COORDINATION

A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.

C. Storage:

1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
2. Store products to allow for inspection and measurement of quantity or counting of units.
3. Store materials in a manner that will not endanger Project structure.
4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.6 PRODUCT WARRANTIES

A. Warranties specified in other Sections are to be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of Owner or endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of Owner or endorsed by manufacturer to Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

    a. Submit additional documentation required by Architect[**through Construction Manager**] in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by Architect, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

    a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

    a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience [**will**][**will not**] be considered[**unless otherwise indicated**].

a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."

4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.

   a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience [**will**][**will not**] be considered[**unless otherwise indicated**].

   a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

   a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

   a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

   1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

E. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in

Division 01 sustainability requirements Section and individual Specification Sections.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:

1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation within [**seven**]<**Insert number**> days of receipt of a request for a comparable product. Architect will notify Contractor[**through Construction Manager**] of approval or rejection of proposed comparable product within [**15**]<**Insert number**> days of receipt of request, or [**seven**]<**Insert number**> days of receipt of additional information or documentation, whichever is later.

1. Architect's Approval of Submittal: [**Marked with approval notation from Architect's action stamp**][**Marked with approval notation from Architect's and Construction Manager's action stamp**][**Indication of approval in web-based Project management software**]<**Insert method**>. See Section 013300 "Submittal Procedures."
2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

C. Submittal Requirements, Two-Step Process: Approval by Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

D. Submittal Requirements, Single-Step Process: When acceptable to Architect, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by Architect of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00 00

Task	Specification	Specification Description
01 60 00 00	01 00 00 00	General Requirements
01 66 00 00	01 00 00 00	General Requirements
01 66 00 00	01 60 00 00	Product Requirements
01 66 19 00	01 00 00 00	General Requirements
01 66 19 00	01 11 19 00	No Specification Required
01 66 19 00	01 60 00 00	Product Requirements
01 66 23 00	01 00 00 00	General Requirements
01 66 23 00	01 60 00 00	Product Requirements
01 70 00 00	01 00 00 00	General Requirements
01 71 00 00	01 00 00 00	General Requirements
01 71 13 00	01 00 00 00	General Requirements
01 71 13 00	01 11 19 00	No Specification Required
01 71 23 00	01 00 00 00	General Requirements
01 71 23 16	01 00 00 00	General Requirements
01 71 36 00	01 00 00 00	General Requirements
01 74 00 00	01 00 00 00	General Requirements
01 74 13 00	01 00 00 00	General Requirements
01 74 16 00	01 00 00 00	General Requirements
01 74 16 00	01 11 19 00	No Specification Required

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SECTION 01 74 19 00 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous [**demolition**][**and**][**construction**] waste.
2. Recycling nonhazardous [**demolition**][**and**][**construction**] waste.
3. Disposing of nonhazardous [**demolition**][**and**][**construction**] waste.

B. Related Requirements:

1. Section 011200 "Multiple Contract Summary" for coordination of responsibilities for waste management.
2. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.
3. Section 044313.13 "Anchored Stone Masonry Veneer" for disposal requirements for excess stone and stone waste.
4. Section 044313.16 "Adhered Stone Masonry Veneer" for disposal requirements for excess stone and stone waste.
5. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.2 DEFINITIONS

A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.

C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner’s property.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may

be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within [**7**][**30**] days of date established for [**commencement of the Work**][**the Notice to Proceed**][**the Notice of Award**].

1.5 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use [**Form CWM-7 for construction waste**][**and**][**Form CWM-8 for demolition waste**]. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in **tons**.
4. Quantity of waste salvaged, both estimated and actual in **tons**.
5. Quantity of waste recycled, both estimated and actual in **tons**.
6. Total quantity of waste recovered (salvaged plus recycled) in **tons**.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. LEED Submittal: Submit documentation to USGBC, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met. Respond to questions and requests from USGBC regarding construction waste management and disposal until the USGBC has made its determination on the project's LEED certification application. Document correspondence with USGBC as informational submittals.

H. Qualification Data: For [**waste management coordinator**][**and**][**refrigerant recovery technician**].

I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

J. Refrigerant Recovery: Comply with requirements in [**Section 024116 "Structure Demolition"**][**Section 024119 "Selective Demolition"**] for refrigerant recovery submittals.

1.6 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent [**may**][**may not**] serve as Waste Management Coordinator.

1. Firm employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator.
2. Waste management coordinator may also serve as LEED coordinator.

B. Refrigerant Recovery Technician Qualifications: [**Type I**][**Type II**][**Type III**][**Universal**] certified by EPA-approved certification program.

C. Refrigerant Recovery Technician Qualifications: Comply with requirements in [**Section 024116 "Structure Demolition."**][**Section 024119 "Selective Demolition."**]

D. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

E. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.7 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis.[**Distinguish between demolition and construction waste.**] Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of [**demolition**][**site-clearing**][**and**][**construction**] waste generated by the Work. Use [**Form CWM-1 for construction waste**][**and**][**Form CWM-2 for demolition waste**]. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use [**Form CWM-3 for construction waste**][**and**][**Form CWM-4 for demolition waste**]. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in

compliance with [**Section 024116 "Structure Demolition."**][**Section 024119 "Selective Demolition."**]

2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use [**Form CWM-5 for construction waste**][**and**][**Form CWM-6 for demolition waste**]. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
6. Savings in transportation and tipping fees by donating materials.
7. Savings in transportation and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of [**50**][**75**] percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials[**.**][**, including the following:**]

1. Demolition Waste:

a. Asphalt paving.
b. Concrete.
c. Concrete reinforcing steel.
d. Brick.
e. Concrete masonry units.
f. Wood studs.
g. Wood joists.
h. Plywood and oriented strand board.
i. Wood paneling.
j. Wood trim.
k. Structural and miscellaneous steel.

l. Rough hardware.
m. Roofing.
n. Insulation.
o. Doors and frames.
p. Door hardware.
q. Windows.
r. Glazing.
s. Metal studs.
t. Gypsum board.
u. Acoustical tile and panels.
v. Carpet.
w. Carpet pad.
x. Demountable partitions.
y. Equipment.
z. Cabinets.
aa. Plumbing fixtures.
bb. Piping.
cc. Supports and hangers.
dd. Valves.
ee. Sprinklers.
ff. Mechanical equipment.
gg. Refrigerants.
hh. Electrical conduit.
ii. Copper wiring.
jj. Lighting fixtures.
kk. Lamps.
ll. Ballasts.
mm. Electrical devices.
nn. Switchgear and panelboards.
oo. Transformers.

2. Construction Waste:

a. Masonry and CMU.
b. Lumber.
c. Wood sheet materials.
d. Wood trim.
e. Metals.
f. Roofing.
g. Insulation.
h. Carpet and pad.
i. Gypsum board.
j. Piping.
k. Electrical conduit.
l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Wood pallets.
8) Plastic pails.

m. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:

1) Paper.
2) Aluminum cans.
3) Glass containers.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.[**Coordinator shall be present at Project site full time for duration of Project.**]

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within [**three**] days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

E. Waste Management in Historic Zones or Areas: Transportation equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, by [**12 inches**] or more.

3.2 SALVAGING DEMOLITION WASTE

A. Comply with requirements in [**Section 024116 "Structure Demolition"**][**Section 024119 "Selective Demolition"**][**Section 024296 "Historic Removal and Dismantling**] for salvaging demolition waste.

B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:

1. Clean salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

C. Salvaged Items for [**Sale**][**and**][**Donation**]: [**Permitted**][**Not permitted**] on Project site.

D. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area [**on-site**][**off-site**][**designated by Owner**].
5. Protect items from damage during transport and storage.

E. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

F. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

G. Plumbing Fixtures: Separate by type and size.

H. Lighting Fixtures: Separate lamps by type and protect from breakage.

I. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING [**DEMOLITION**][**AND**][**CONSTRUCTION**] WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall [**accrue to Owner**][**accrue to Contractor**][**be shared equally by Owner and Contractor**].

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

   a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and

shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Grind asphalt to maximum [**1-1/2-inch**][**4-inch**] size.

1. Crush asphaltic concrete paving and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill.

B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum [**1-1/2-inch**][**4-inch**] size.
2. Crush concrete and screen to comply with requirements in Section 312000 "Earth Moving" for use as satisfactory soil for fill or subbase.

D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Pulverize masonry to maximum [**3/4-inch**][**1-inch**][**1-1/2-inch**][**4-inch**] size.

a. Crush masonry and screen to comply with requirements in Section 312000 "Earth Moving" for use as [**general fill**][**satisfactory soil for fill or subbase**].
b. Crush masonry and screen to comply with requirements in Section 329300 "Plants" for use as mineral mulch.

2. Clean and stack undamaged, whole masonry units on wood pallets.

E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

F. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

J. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.

K. Carpet[**and Pad**]: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet[**and pad**] in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

L. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

M. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.

N. Conduit: Reduce conduit to straight lengths and store by material and size.

O. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

a. Comply with requirements in Section 329300 "Plants" for use of clean sawdust as organic mulch.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

a. Comply with requirements in Section 329300 "Plants" for use of clean ground gypsum board as inorganic soil amendment.

D. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and

areas.

B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner’s property.

C. Burning: Do not burn waste materials.

D. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

3.7 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

C. Form CWM-3 for construction waste reduction work plan.

D. Form CWM-4 for demolition waste reduction work plan.

E. Form CWM-5 for cost/revenue analysis of construction waste reduction work plan.

F. Form CWM-6 for cost/revenue analysis of demolition waste reduction work plan.

G. Form CWM-7 for construction waste reduction progress report.

H. Form CWM-8 for demolition waste reduction progress report.

END OF SECTION 01 74 19 00

Task	Specification	Specification Description
01 74 19 00	01 00 00 00	General Requirements
01 74 19 00	01 11 19 00	No Specification Required
01 74 23 00	01 00 00 00	General Requirements
01 00 00 00MOD000	01 00 00 00	General Requirements
01 00 00 00MOD000	26 01 00 00	Supplemental Requirements for Electrical

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Task	Specification	Specification Description
02 32 00 00	01 11 19 00	No Specification Required
02 32 13 00	01 11 19 00	No Specification Required
02 32 19 00	01 11 19 00	No Specification Required
02 41 13 13	02 41 19 00	Selective Demolition

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SECTION 02 41 16 00 - STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Demolition and removal of buildings or structures.
2. Demolition and removal of site improvements.
3. Abandoning in-place below-grade construction.
4. Removing below-grade construction.
5. Disconnecting, capping or sealing, and abandoning in-place site utilities.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Salvaging items for reuse by Owner.

B. Related Requirements:

1. Section 011000 "Summary" for use of the premises and phasing requirements.
2. Section 013200 "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
3. Section 024119 "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
4. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade site improvements that are not part of building demolition.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated. Include fasteners or brackets needed for reattachment elsewhere.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 COORDINATION

A. Arrange demolition schedule so as not to interfere with [**Owner's on-site operations**][**or**][**operations of adjacent occupied buildings**].

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at [**Project site**].

1. Inspect and discuss condition of construction to be demolished.
2. Review structural load limitations of existing structures.
3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review and finalize protection requirements.
5. Review procedures for [**noise control**][**and**][**dust control**].
6. Review procedures for protection of adjacent buildings.
7. Review storage, protection, and accounting for items to be salvaged and returned to Owner.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**refrigerant recovery technician**][**specialty demolition contractor**].

B. Engineering Survey: Submit engineering survey of condition of building.

C. Survey of Existing Conditions: Submit survey.

D. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property[**, for environmental protection**][**, for dust control**][**and**][**, for noise control**]. Indicate proposed locations and construction of barriers.

1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain[**including means of egress from those buildings**].

E. Schedule of Building Demolition Activities: Indicate the following:

1. Detailed sequence of demolition work, with starting and ending dates for each activity.
2. Temporary interruption of utility services. Indicate how long services will be interrupted.
3. Coordination for shutoff and capping[**or re-routing**] of utility services.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed in accordance with EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: [**Type I**][**Type II**][**Type III**][**Universal**] certified by an EPA-approved certification program.

B. Specialty Demolition Contractor Qualifications: A competent person [**licensed by the authority having jurisdiction,**]who has training, knowledge, or experience in the use of each type of blasting method used and in the field of transporting, storing, handling, and using explosives; and has a working

knowledge of state and local laws and regulations pertaining to explosives.

1.9 FIELD CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.

B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.

1. Provide not less than [**72**] hours' notice of activities that will affect operations of adjacent occupied buildings.
2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.

a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.

C. Conditions existing at time of inspection for bidding purpose will be maintained the Owner as far as practical.

D. Hazardous Materials:

1. It is not expected that hazardous materials will be encountered in the Work.

a. Hazardous materials will be removed by Owner before start of the Work.
b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner. Hazardous materials will be removed by Owner under a separate contract.

2. Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is [**on file**][**included in Section 003126 "Existing Hazardous Material Information"**] for review and use. Examine report to become aware of locations where hazardous materials are present.

a. The Owner will provide material safety data sheets for hazardous materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.

E. On-site sale of removed items or materials is not permitted.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

2.2 SOIL MATERIALS

A. Satisfactory Soils: Comply with requirements in Section 312000 "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. [**Perform**][**Engage a professional engineer to perform**] an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video[**, measured drawings**][**and**][**templates**]. Comply with Section 013233 "Photographic Documentation."

1. Inventory and record the condition of items to be removed and salvaged. Photograph or video conditions that might be misconstrued as damage caused by removal.
2. Photograph or video existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations or removal of items for salvage.

3.2 PREPARATION

A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of demolition.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities and Controls."

1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.

D. Existing Utilities to Remain: Maintain utility services to remain and protect against damage during demolition operations.

1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.

    a. Provide at least [**72**] hours' notice to occupants of affected buildings if shutdown of service is required during changeover.

E. Existing Utilities to Be Disconnected: Locate, identify, disconnect, and seal or cap off utilities serving buildings and structures to be demolished.

1. Owner will arrange to shut off utilities when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If disconnection of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
4. Cut off pipe or conduit a minimum of [**24 inches**] below grade at or outside the building or structure to be demolished and cap, valve, or plug and seal remaining portion of pipe or conduit [**after bypassing**]in accordance with requirements of authorities having jurisdiction.
5. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing by authorities having jurisdiction.

F. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment in accordance with 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 SALVAGE

A. Items to be removed and salvaged are indicated[**on Drawings.**][**below:**]

1. Doors and door hardware.
2. Windows.
3. Cabinets.
4. Mirrors.
5. Tackboards.
6. White boards.
7. Plumbing fixtures.

B. Comply with the following for salvaged items:

1. Clean salvaged items of dirt and demolition debris.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.

3. Store items in a secure area until delivery to Owner.
4. Transport items to storage area [**designated by Owner**][**indicated on Drawings**].
5. Protect items from damage during transport and storage.

3.4 DEMOLITION, GENERAL

A. General: Demolish indicated buildings[**and site improvements**] completely. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
2. Maintain adequate ventilation when using cutting torches.
3. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

C. Explosives: Use of explosives is not permitted.

3.5 DEMOLITION BY EXPLOSIVES

A. Explosives: Perform explosive demolition operations in accordance with ANSI/ASSP A10.7 and regulations of authorities having jurisdiction.

1. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
2. Do not damage adjacent structures, property, or site improvements when using explosives.

B. Comply with recommendation in specialty explosives consultant's report.

3.6 DEMOLITION BY MECHANICAL MEANS

A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

C. Below-Grade Construction:

1. Abandon foundation systems and other below-grade construction. Cut below-grade construction flush with grade.
2. Demolish foundation systems and other below-grade construction that are within footprint of new construction and extending [**5 ft.**] outside footprint indicated for new construction. Abandon below-grade construction outside this area.

    a. Remove below-grade construction, including basements, foundation systems, and footings, [**completely**][**to at least 6 inches below grade**][**to at least 12 inches below grade**][**to depths indicated**].

3. Demolish foundation systems and other below-grade construction.

    a. Remove below-grade construction, including basements, foundation systems, and footings, [**completely**][**to at least 6 inches below grade**][**to at least 12 inches below grade**][**to depths indicated**].

D. Existing Utilities:

1. Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.
2. Demolish existing utilities and below-grade utility structures that are within [**5 ft.**] outside footprint indicated for new construction. Abandon utilities outside this area.

    a. Fill abandoned utility structures with [**satisfactory soil materials**][**recycled pulverized concrete**] in accordance with backfill requirements in Section 312000 "Earth Moving."

3. Demolish and remove existing utilities and below-grade utility structures.

E. Hydraulic Elevator Systems: Demolish and remove elevator system, including cylinder, plunger, well assembly, steel well casing and liner, oil supply lines, and tanks.

3.7 SITE RESTORATION

A. Below-Grade Areas:

1. Rough grade below-grade areas ready for further excavation or new construction.
2. Completely fill below-grade areas and voids resulting from building demolition operations with [**satisfactory soil materials**][**recycled pulverized concrete**][**recycled pulverized masonry**] in accordance with backfill requirements in Section 312000 "Earth Moving."

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.8 REPAIRS

A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.9 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site [**and dispose of them in an EPA-approved**

construction and demolition waste landfill acceptable to authorities having jurisdiction.][**and recycle or dispose of them in accordance with Section 017419 "Construction Waste Management and Disposal."**]

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.10 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

1. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16 00

SECTION 02 41 16 13 - BUILDING DEMOLITION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for building demolition. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Demolition and removal of buildings and site improvements.
b. Abandoning in place **OR** Removing, **as directed**, below-grade construction.
c. Disconnecting, capping or sealing, and abandoning in-place **OR** removing, **as directed**, site utilities.
d. Salvaging items for reuse by the Owner.

C. Definitions
1. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.
2. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to the Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

D. Materials Ownership
1. Unless otherwise indicated, demolition waste becomes property of Contractor.
2. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to the Owner that may be uncovered during demolition remain the property of the Owner.
a. Carefully salvage in a manner to prevent damage and promptly return to the Owner.

E. Informational Submittals
1. Qualification Data: For refrigerant recovery technician.
2. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control, **as directed**. Indicate proposed locations and construction of barriers.
a. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.
3. Schedule of Building Demolition Activities: Indicate the following:
a. Detailed sequence of demolition work, with starting and ending dates for each activity.
b. Temporary interruption of utility services.
c. Shutoff and capping or re-routing of utility services.
4. Inventory: Submit a list of items to be removed and salvaged and deliver to the Owner prior to start of demolition.
5. Predemolition Photographs **OR** Video, **as directed**: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Submit before the Work begins.
6. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
7. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that

recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Quality Assurance
1. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
2. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
3. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.
4. Predemolition Conference: Conduct conference at Project site.
   a. Inspect and discuss condition of construction to be demolished.
   b. Review structural load limitations of existing structures.
   c. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Review and finalize protection requirements.
   e. Review procedures for noise control and dust control.
   f. Review procedures for protection of adjacent buildings.
   g. Review items to be salvaged and returned to the Owner.

G. Project Conditions
1. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
2. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
   a. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
   b. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
      1) Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
3. the Owner assumes no responsibility for buildings and structures to be demolished.
   a. Conditions existing at time of inspection for bidding purpose will be maintained by the Owner as far as practical.
   b. Before building demolition, the Owner will remove certain items, as directed by the Owner.
4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   a. Hazardous materials will be removed by the Owner before start of the Work.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and the Owner. Hazardous materials will be removed by the Owner under a separate contract.

   OR

   Hazardous Materials: Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   a. Hazardous material remediation is specified elsewhere in the Contract Documents.
   b. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
   c. the Owner will provide safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.
5. On-site storage or sale of removed items or materials is not permitted.

H. Coordination
1. Arrange demolition schedule so as not to interfere with the Owner's on-site operations **OR** operations of adjacent occupied buildings, **as directed**.

1.2 PRODUCTS

A. Soil Materials
1. Satisfactory Soils: Satisfactory Soils: For soils which is to be used for backfilling voids that result from demolition operations in below-grade areas, comply with requirements in Division 31 Section “Earth Moving".

1.3 EXECUTION

A. Examination
1. Verify that utilities have been disconnected and capped before starting demolition operations.
2. Review Project Record Documents of existing construction provided by the Owner. the Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
3. Inventory and record the condition of items to be removed and salvaged. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by salvage operations.
4. Perform **OR** Engage a professional engineer to perform, **as directed**, an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
   a. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
5. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

B. Preparation
1. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
2. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
   a. the Owner will arrange to shut off indicated utilities when requested by Contractor.
      OR
      Arrange to shut off indicated utilities with utility companies, **as directed**.
   b. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
   c. Cut off pipe or conduit a minimum of 24 inches (610 mm) below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

   OR

   Existing Utilities: Refer to Division 22 & Division 26 for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing, **as directed**.
3. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
   a. Strengthen or add new supports when required during progress of demolition.
4. Salvaged Items: Comply with the following:
   a. Clean salvaged items of dirt and demolition debris.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until delivery to the Owner.
   d. Transport items to storage area designated by the Owner **OR** indicated on Drawings, **as directed**.
   e. Protect items from damage during transport and storage.

C. Protection
1. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
2. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
   a. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by the Owner and authorities having jurisdiction.
   b. Provide temporary services during interruptions to existing utilities, as acceptable to the Owner and authorities having jurisdiction.
      1) Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
3. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction, and as indicated. Comply with requirements in Division 1 Section “Temporary Facilities And Controls".
   a. Protect adjacent buildings and facilities from damage due to demolition activities.
   b. Protect existing site improvements, appurtenances, and landscaping to remain.
   c. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
   d. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   e. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
   f. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
   g. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
4. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

D. Demolition, General
1. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
   a. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
   b. Maintain fire watch during and for a specified time after flame cutting operations as directed by the Owner.
   c. Maintain adequate ventilation when using cutting torches.
   d. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
2. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.
3. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   a. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
   b. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
4. Explosives: Use of explosives is not permitted, **unless directed otherwise**.

E. Demolition By Mechanical Means
1. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   a. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
3. Salvage: Items to be salvaged are indicated on Drawings **OR** below, **as directed**:
   a. Doors and door hardware.
   b. Windows.
   c. Cabinets.
   d. Mirrors.
   e. Chalkboards.
   f. Tackboards.
   g. Marker boards.
   h. Plumbing fixtures.
   i. Other items as directed.
4. Below-Grade Construction: Abandon foundation walls and other below-grade construction. Cut below-grade construction flush with grade.
   OR
   Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet (1.5 m) outside footprint indicated for new construction. Abandon below-grade construction outside this area.
   a. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.
   OR
   Below-Grade Construction: Demolish foundation walls and other below-grade construction.
   b. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.
5. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.
   OR
   Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet (1.5 m) outside footprint indicated for new construction. Abandon utilities outside this area.
   a. Fill abandoned utility structures with satisfactory soil materials **OR** recycled pulverized concrete, **as directed**, according to backfill requirements in Division 31 Section “Earth Moving".
   b. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   c. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.
   OR
   Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
   a. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   b. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

F. Demolition By Explosives – ONLY IF APPROVED BY THE OWNER
1. Explosives: Perform explosive demolition according to governing regulations.
   a. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
   b. Do not damage adjacent structures, property, or site improvements when using explosives.
2. Comply with recommendation in Explosives Consultant's report.

G. Site Restoration
   1. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
      OR
      Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials **OR** recycled pulverized concrete **OR** recycled pulverized masonry, **as directed**, according to backfill requirements in Division 31 Section “Earth Moving".
   2. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

H. Repairs
   1. Promptly repair damage to adjacent buildings caused by demolition operations.

I. Disposal Of Demolished Materials
   1. Remove demolition waste materials from Project site and legally dispose of them in EPA approved landfill acceptable to authorities having jurisdiction. See Division 1 Section “Construction Waste Management And Disposal" for recycling and disposal of demolition waste.
      a. Do not allow demolished materials to accumulate on-site.
      b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   2. Do not burn demolished materials.

J. Cleaning
   1. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
      a. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16 13

Task	Specification	Specification Description
02 41 16 13	02 41 16 00	Structure Demolition
02 41 16 13	02 41 19 00	Selective Demolition

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SECTION 02 41 19 00 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Demolition and removal of selected portions of exterior or interior of building or structure and site elements.
2. Removal and salvage of existing items for delivery to Owner and removal of existing items for reinstallation.

B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
3. Section 017300 "Execution" for cutting and patching procedures.
4. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
5. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.
6. Section 330500 "Common Work Results for Utilities" for removal of site utility systems piping, equipment, and components.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage; prepare for reuse; and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at [**Project site**].

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.
6. Review and finalize protection requirements.
7. Review procedures for [**noise control**][**and**][**dust control**].
8. Review storage, protection, and accounting for items to be removed for salvage or reinstallation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For refrigerant recovery technician.

B. Engineering Survey: Submit engineering survey of condition of building.

C. Survey of Existing Conditions: Submit survey.

D. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property[**, for environmental protection**][**, for dust control**][**and**][**, for noise control**]. Indicate proposed locations and construction of barriers.

E. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Temporary interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed in accordance with EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: [**Type I**][**Type II**][**Type III**][**Universal**] certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

A. Owner will [**not**]occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by the Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials:

1. It is not expected that hazardous materials will be encountered in the Work.

    a. Hazardous materials will be removed by Owner before start of the Work.
    b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

2. Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is [**on file**][**included in Section 003126 "Existing Hazardous Material Information"**] for review and use. Examine report to become aware of locations where hazardous materials are present.

    a. The Owner will provide material safety data sheets for hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.

E. Historic Areas: Demolition and hauling equipment and other materials to be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by [**12 inches**] or more.

F. On-site sale of removed items or materials is not permitted.

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

C. Sustainable Design Requirements for Building Reuse:

1. Maintain the existing building structure, envelope, and interior nonstructural elements of an abandoned or blighted building. Do not demolish such existing construction beyond indicated limits.
2. Maintain the existing building structural systems where indicated to remain. Do not demolish such existing construction beyond indicated limits.
3. Maintain the existing interior ceilings, interior partitions, and/or demountable walls where indicated to remain. Do not demolish such existing construction beyond indicated limits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. [**Perform**][**Engage a professional engineer to perform**] an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video[**, measured drawings**][**and**][**templates**]. Comply with Section 013233 "Photographic Documentation."

1. Inventory and record the condition of items to be removed for salvage or reinstallation. Photograph or video conditions that might be misconstrued as damage caused by removal.

2. Photograph or video existing conditions of adjoining construction including finish surfaces, that might be misconstrued as damage caused by selective demolition operations or removal of items for salvage or reinstallation.

3.2 PREPARATION

A. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

B. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location[**and cleaned**] and reinstalled in their original locations after selective demolition operations are complete.

D. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment in accordance with 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND BUILDING SYSTEMS

A. Existing Services/Systems to Remain: Maintain utilities and building systems and equipment to remain and protect against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utilities and building systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If disconnection of utilities and building systems will affect adjacent occupied parts of the building, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to those parts of the building.
4. Demolish and remove existing building systems, equipment, and components indicated on Drawings to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug

remaining piping with same or compatible piping material.
b. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
c. Equipment to Be Removed: Disconnect and cap services and remove equipment and components.

5. Abandon existing building systems, equipment, and components indicated on Drawings to be abandoned in place.

a. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
b. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

6. Remove and reinstall/salvage existing building systems, equipment, and components indicated on drawings to be removed and reinstalled or removed and salvaged:

a. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment and components; when appropriate, reinstall, reconnect, and make equipment operational.
b. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and components and deliver to Owner.

3.4 SALVAGE/REINSTALL

A. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area [**on-site**][**off-site**][**designated by Owner**][**indicated on Drawings**].
5. Protect items from damage during transport and storage.

B. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" to mean historic "removal" or "dismantling" as specified in Section 024296 "Historic Removal and Dismantling."

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete:

1. Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least **3/4 inch** at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
2. Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

D. Resilient Floor Coverings: Remove floor coverings and adhesive in accordance with recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."[**Do not use methods requiring solvent-based adhesive strippers.**]

E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so

that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site [**and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.**][**and recycle or dispose of them in accordance with Section 017419 "Construction Waste Management and Disposal."**]

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19 00

SECTION 02 41 19 13 - CUTTING AND PATCHING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cutting and patching. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes procedural requirements for cutting and patching.

C. Definitions
1. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
2. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

D. Submittals
1. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   a. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   b. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   c. Products: List products to be used and firms or entities that will perform the Work.
   d. Dates: Indicate when cutting and patching will be performed.
   e. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   f. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
   g. the Owner's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

E. Quality Assurance
1. LEED Requirements for Building Reuse:
   a. Credit MR 1.1 and 1.2, **as directed**: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   b. Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   c. Credit MR 1.2 and 1.3, **as directed**: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be removed; do not cut such existing construction beyond indicated limits.

2. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
   a. **Refer to the Owner for list of elements that might otherwise be overlooked as structural elements and that require Architect's or Construction Manager's approval of a cutting and patching proposal**.
3. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
   a. Primary operational systems and equipment.
   b. Air or smoke barriers.
   c. Fire-suppression systems.
   d. Mechanical systems piping and ducts.
   e. Control systems.
   f. Communication systems.
   g. Conveying systems.
   h. Electrical wiring systems.
   i. Operating systems of special construction in Division 13.
4. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
   a. Water, moisture, or vapor barriers.
   b. Membranes and flashings.
   c. Exterior curtain-wall construction.
   d. Equipment supports.
   e. Piping, ductwork, vessels, and equipment.
   f. Noise- and vibration-control elements and systems.
5. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
6. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

F. Warranty
1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

1.2 PRODUCTS

A. Materials
1. General: Comply with requirements specified in other Sections.
2. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   a. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

1.3 EXECUTION

A. Preparation
1. Temporary Support: Provide temporary support of Work to be cut.
2. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
3. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
4. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize **OR** prevent, **as directed**, interruption to occupied areas.

B. Performance
1. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   a. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   a. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   b. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   c. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   d. Excavating and Backfilling: Comply with requirements in applicable Division 31 where required by cutting and patching operations.
   e. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   f. Proceed with patching after construction operations requiring cutting are complete.
3. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
   a. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   b. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
      1) Clean piping, conduit, and similar features before applying paint or other finishing materials.
      2) Restore damaged pipe covering to its original condition.
   c. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      1) Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

d. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
e. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

4. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 02 41 19 13

Task	Specification	Specification Description
02 41 19 13	02 41 19 00	Selective Demolition
02 41 19 16	02 41 19 00	Selective Demolition
02 42 21 35	02 41 19 00	Selective Demolition
02 42 21 47	02 41 19 00	Selective Demolition
02 43 13 00	01 11 19 00	No Specification Required
02 43 13 13	01 11 19 00	No Specification Required

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SECTION 02 61 00 00 - REMOVAL AND DISPOSAL OF CONTAMINATED SOILS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for disposal of hazardous materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definition
1. Hazardous materials shall be defined as asbestos containing materials, lead-based paint, PCBs, bird waste, and other materials categorized as hazardous by the EPA.

C. Submittals
1. Before start of work: At the pre-construction meeting, the Contractor shall submit the following to the Owner's Representative for review. Do not start work until these submittal are returned with Owner's Representative stamp indicating that the submittal is returned for unrestricted use.
   a. Copy of State or local license for hazardous waste hauler.
   b. Certificate of at least one on-site supervisor which has satisfactorily completed the OSHA 40 hour Health and Safety course for handling hazardous materials.
   c. Certificates of workers which have successfully completed the OSHA 40-Hour Health and Safety Course for Hazardous Materials.
   d. List of the employees scheduled to perform this work.
   e. Schedule of start and finish times and dates for this work.
   f. Name and address of landfill where these waste materials are to be deposited. Include contact person and telephone number.
   g. Safety Data Sheet (SDS) for all materials to be removed.
   h. If contractor introduces any chemical into the work environment, a SDS for that chemical must be presented to the Owner's Representative prior to use.
   i. Transporter must have notified the EPA and/or other appropriate local government agency in advance of its intentions to transport hazardous materials and, if applicable, receive an identification number.
   j. Contingency Plan for handling emergencies with spills or leaks.
   k. Certificates of workers which have successfully completed the OSHA 24-Hour Health and Safety Course for Hazardous Materials.

1.2 PRODUCTS

A. Materials
1. Drums: Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA, EPA (40 CFR Parts 264-264 and 300), and DOT Regulations (49 CFR Parts 171-178). Use of damaged containers shall not be allowed.
2. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
3. Absorbent Material: Clay, soil or any commercially available absorbent used for the purpose of absorbing hazardous or potentially hazardous materials.

1.3 EXECUTION

A. All waste shall be transported and disposed of in accordance with all federal, state and local guidelines and regulations. The contractor is to obtain all permits, licenses, etc., which are necessary for the transporting and disposal of hazardous waste.

B. Waste haulers shall maintain waste manifest and shipment record forms.

END OF SECTION 02 61 00 00

Task	Specification	Specification Description
02 61 13 00	02 41 19 00	Selective Demolition
02 61 13 00	02 61 00 00	Removal and Disposal of Contaminated Soils
02 61 26 00	02 61 00 00	Removal and Disposal of Contaminated Soils
02 61 26 00	02 82 33 00	Removal Of Friable Asbestos-Containing Materials
02 65 00 00	02 41 19 00	Selective Demolition

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SECTION 02 82 16 00 - ENGINEERING CONTROL OF ASBESTOS CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for encapsulation (lock-down) of asbestos-containing materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: Manufacturers technical information including label analysis and application instructions for each material proposed for use.
2. Installation Instructions: Manufacturer's installation instructions with specific project requirements noted.
3. Performance Warrantee: Manufacturers performance guarantee.
4. Safety Data Sheet: Safety Data Sheet in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

C. Delivery And Storage: Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
1. Name or title of material
2. Manufacturer's stock number and date of manufacture
3. Manufacturer's name
4. Thinning instructions
5. Application instructions
6. Deliver materials together with a copy of the OSHA Material
7. Safety Data Sheet for the material.

D. Job Conditions: Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.

E. Quality Assurance
1. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 “Standard Practice for Encapsulants for Spray-or-Trowel-Applied Friable Asbestos- Containing Building Materials."

F. Warranty
1. Performance Warranty: Contractor shall submit written Performance Warranty, executed by the contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, unforeseeable ambient exposures or other causes beyond anticipated conditions and contractors control. Warranty period shall be for at least one year after date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Encapsulant system shall be an acrylic, elastomeric type, spray, brush or roller-applied, tinted penetrating or tinted bridging type, specifically designed for application to asbestos-containing material. System shall be equal to Global Encasement System as manufactured by GLOBAL

Encasement Inc., 132-32nd Street, Union City, NJ 07087 U.S.A., Tel. (800) 266-3982/(201) 902-9770.

a. All encasement topcoat materials shall be warranted to be heavy-bodied, from the same manufacturer, and shall be long lasting, highly-pure (low VOC) materials that remain flexible, chalk resistant and resist cracking, peeling, algae and fungus that can cause future indoor air quality concerns.
b. To allow for building movement without cracking or disturbing fibrous materials, coating systems shall have passed testing to ASTM standards for adhesion, permeability, aged flexibility and with aged elasticity for the encasement system of over 250%.
c. Coatings shall be Class A Fire Rated, water-based, non-toxic, safe and easy to use, contain no hazardous ingredients by OSHA definition, comply with all known building codes and be non-flammable.
d. Coating materials shall have low VOC (Volatile Organic Compound) content.
e. Coating materials shall not release health threatening toxic smoke and fumes in a fire and shall comply with all known building codes.
f. Coating materials shall have passed the following testing standards:
    1) ASTM E 119 fire tests demonstrating that applying a multi-layer system over fireproofing does not adversely affect the fireproof rating of the fireproofing (3 hour test).
    2) UPITT Combustion Toxicity Test proving nothing toxic is released in a fire.
    3) ASTM E 84 and E162 fire tests for "Class A" - Surface Flammability and Burning Characteristics (Flame Spread = 0, Smoke Developed = 5).
    4) "Pull-off Adhesion" test per ASTM E736 equals or exceeds 9,950 lbs./sq. ft. (89.1 lbs./sq. in.).
    5) ASTM D 1653 and E96 "Water Vapor Permeability" (showing the rate that water vapor can pass through the system).
    6) Impact Resistance, "Tensile Strength" shall exceed 150 psi; "Elongation" shall exceed 250%.
    7) System shall be mildew resistant, impact resistant, scrub resistant, non-yellowing, non-chalking, highly blister resistant, rust resistant, highly chemical resistant and shall remain flexible after 1000 hour ASTM Accelerated Weather testing.
    8) Water-Based materials (low VOC) Volatile Organic Content of Primer-Sealer-Neutralizer = 0.1 g/L (0.001 lb./gal.) and Encasement Top Coat = 0.1 g/L (0.001 lb./gal.) as tested by EPA Method 24.
    9) Materials comply with applicable standards for installation on interior and/or exterior surfaces of a building.
    10) Encasement Systems shall provide additional water-proofing protection.

B. Related Materials:
    1. Elastomeric architectural sealants, caulking compounds, primers, and similar materials shall be approved by the manufacturer of the encasement coatings. All materials used shall be applied in accordance with its manufacturer's recommendations.

C. Applicable Standards
    1. Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E 1494.

1.3 EXECUTION

A. General
    1. Prior to applying any encapsulating material in Work Areas, Contractor shall obtain final visual inspection approval by the Project Administrator.
    2. Prior to applying any encapsulating material, Contractor shall ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or

separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.

3. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.

B. Worker Protection
   1. Before beginning work with any material for which a Safety Data Sheet has been submitted provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

C. Application
   1. Comply with all manufacturer's instructions for particular conditions of installation. Consult with manufacturer's technical representative for conditions not covered.
   2. Encapsulate all surfaces in full compliance with manufacturer's procedures.
   3. At completion of Encapsulation and before removal of Work Area enclosures and Pressure Differential System, decontaminate space in accordance with requirements of manufacturer’s instructions.
   4. Remove all debris from the project site and restore area to proper conditions by cleaning all surfaces in accordance with manufacturer’s written recommendations.
   5. At completion of work submit manufacturer’s record of inspection of completed work and Manufacturers Performance Guarantee executed by both manufacturer and Contractor.

END OF SECTION 02 82 16 00

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SECTION 02 82 33 00 - REMOVAL OF FRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for removal of friable asbestos-containing materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Description
1. Furnish all labor, materials, facilities, equipment, services, employee training and testing, permits and agreements necessary to perform the work required for asbestos removal, encapsulation, repair, clean-up, decontamination, re-insulation and all other work in accordance with these specifications, in accordance with the latest regulations from the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the recommendations of National Institute of Occupational Safety and Health (NIOSH), and any other applicable federal, state and local government regulations. Whenever there is a conflict or overlap of the above references, the most stringent provision is applicable.
2. The work specified herein shall be performed by competent persons trained, knowledgeable and qualified in the state-of-the-art techniques of asbestos abatement, handling and subsequent cleaning of contaminated areas.

C. Scope
1. The quantities of materials and limits of abatement work area(s) shall be verified by the asbestos contractor.

D. Asbestos Hazard
1. Asbestos-containing material when damaged or disturbed is subject to fiber releases. Wet methods are a primary means of controlling fiber release.
2. Strict compliance with each of the provisions outlined in these specifications for the encapsulation, repair and handling of asbestos-containing material is of great importance, because:
    a. The inhalation of airborne asbestos fibers can cause a very serious and often fatal disease.
    b. Workers may not be aware they are inhaling asbestos fibers.
    c. Symptoms of the disease do not appear for many years.
    d. Only the Contractor and its employees can prevent the inhalation of asbestos fibers, which can lead to the development of asbestos-related disease.
    e. No insurance is available to provide for asbestos-related disease.

E. Other Hazardous Material
1. Contractor shall comply with OSHA 29 CFR 1926.62 - Lead in Construction when demolishing any equipment or architectural component identified as lead-containing or lead-based paint. The work of this project is considered a demolition activity.
2. the Owner anticipates that a substantial amount of the Project will involve lead paint.

F. Qualifications
1. the Owner and the Owner's Representative will verify and approve the experience of the Asbestos Abatement Contractor based upon submission at the time of bidding by Contractor evidence of the following:
    a. Experience: Provide the names and locations of at least three asbestos abatement projects of comparable size and complexity comparable with this work. Provide the names

and telephone numbers of contact person at previous projects. Provide the final air monitoring decontamination fiber levels achieved.

b. Personnel: Provide the name(s) of "Competent Person" as defined by OSHA 29 CFR 1926.32(f) - Asbestos. Demonstrate the education and specialized training with successful completion of examination of an EPA approved course. Provide evidence of participation in five projects of complexity comparable with this project.

c. Licensing and Certification: The Contractor must hold a current, valid asbestos license issued by the State in which the work is to be performed.

G. Notices And Record Keeping

1. Contractor shall maintain for at least 30 years, a record for each asbestos project in which the Contractor engages. Each record shall include the following information: name, address, and social security number of all personnel involved with the project, the name address and social security number of the OSHA "Competent Person" who will supervise the work, the amount of asbestos material that was removed, repaired, encapsulated or disturbed, the commencement and completion date of the work, copies of Hazardous Waste Manifest(s), personal air monitoring results and any other appropriate information.
2. The Contractor shall send written notification as required by USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61, Subpart M) to the Owner, at least 10 working days prior to beginning any work on asbestos-containing materials.
3. Include the following information:
   a. Name and address of the Owner or operator.
   b. Description of the facility being demolished or renovated, including the size, age, and prior use of the facility.
   c. Estimate of the approximate amount of asbestos material present in the facility in terms of linear feet of pipe, and surface area on other facility components. For facilities in which the amount of asbestos materials is less than 260 linear feet on pipes and less than 160 square feet on other facility components, explain techniques of estimation.
   d. Location of the facility being demolished or renovated.
   e. Scheduled starting and completion dates of demolition or renovation.
   f. Nature of planned demolition or renovation and method(s) to be used.
   g. Procedures to be used to comply with the requirements of USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61 Subpart M).
   h. Name and location of the waste disposal site where the asbestos waste material will be deposited.
4. Prior to commencement of work, the Contractor shall submit the following documents to the Owner's Representative. No work will be allowed to start until these documents have been approved:
   a. The schedule of the work, including manpower, length and number of work shifts. Schedule shall be coordinated with the Owner's full occupancy of all areas of the building.
   b. Satisfactory proof that written notification has been provided to the EPA regional office and the Owner.
   c. Proof that all required permits, disposal site locations, and arrangements for transportation and disposal of asbestos-contaminated materials, supplies and the like have been obtained.
   d. Complete a worker certificate indicating that all employees have had instruction and training on the hazards of asbestos exposure, the use and fitting of respirators, protective dress, wet and dry decontamination procedures, entry and exit from work areas, and all aspects of work procedures and protective measures.
   e. Documentation indicating that all employees have received appropriate medical examinations and have successfully passed fit testing for the respirator to be worn. As a

minimum, medical exams must be consistent with OSHA 29 CFR 1926.1101(K)(9)(viii)(G)-Asbestos Regulation.

f. Samples of signs to be used in and around the work area to comply with 0SHA 29 CFR 1926.1101(K)(9)(viii)(I)- Asbestos regulations and as required by federal, state and municipal regulations.

g. Safety Data Sheets (OSHA form 174 or equivalent) for all chemicals used during work performed under this section.

h. Encapsulation data and encapsulation procedures.

i. Design of pressure differential system including calculation used to arrive at the number of machines necessary to achieve one air change per every 10 minutes.

j. Location of personnel and material decontamination units for each work area.

5. Contractor shall provide written notification to the Owner's Representative of its intent to start work at least five days in advance. In no case will the Contractor start work until authorization to proceed is given.

6. During the work, Contractor shall maintain a daily log which will be kept at the job site. Items to be included in the daily log shall include but are not limited to the following:

a. Meetings, purpose, attendees, discussions, items of resolution.

b. Visitations, authorized and unauthorized.

c. Sign-in sheets of all personnel entering and leaving the work area.

d. Special or unusual events (i.e., barrier breeching equipment failures).

e. Personal air monitoring results.

f. Two copies of the daily log are required for Project Closeout.

H. Terminology (Definitions)

1. Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, enclosure or encapsulation.

2. Air Lock - A system for permitting ingress or egress without permitting air movement between any two adjacent areas consisting of two curtained doorways. The air lock must be maintained in an uncontaminated condition at all times.

3. Air Monitoring; - The process of measuring the asbestos fiber content of a specific volume of air in a stated period of time using methods approved or recommended by OSHA, EPA, NIOSH or other method approved by the Owner or the Owner's Representative.

4. Amended water - Water to which a surfactant has been added.

5. Asbestos - A generic name given to a number of naturally occurring hydrated mineral silicates that possess a unique crystalline structure, are incombustible in air, and are separable into fibers. Asbestos includes the asbestiform varieties of Chrysotile (serpentine), Crocidolite (Riebeckite), Amosite (Cummingtonite-Grunente), Anthophyllite, Actinolite, and Tremolite.

6. Asbestos-containing. material (ACM) - Any material that contains more than 1 percent asbestos by weight as determined by Polarized Light Microscopy (PLM).

7. Authorized Visitor - the Owner or its designated representative, or a representative of any regulatory or other agency having jurisdiction over the project.

8. Class I - Asbestos work means activities involving the removal of thermal systems insulation (TSI) and surfacing ACM and PACM.

9. Class II - Asbestos work means activities involving the removal of ACM which is not TSI or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.

10. Class III - Asbestos work means repair and maintenance operations where "ACM" including TSI and surfacing ACM and PACM is likely to be disturbed.

11. Class IV - Asbestos work means maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean-up dust, waste and debris resulting from Class I, II and III activities.

12. Critical Barrier - A unit of temporary construction which provides the only separation between an asbestos work area and an adjacent, potentially occupied, space. The critical barrier is composed of at least one intact sheet of polyethylene sheeting.

13. Decontamination Enclosure System - A series of connected rooms with curtained doorways between any two adjacent rooms, for the decontamination of workers or of materials and equipment. A decontamination system contains at least two air locks.
14. Disposal - All procedures necessary to transport and deposit the asbestos-contaminated material stripped and removed from the building in a waste disposal site in compliance with applicable federal, state, and local regulations.
15. Disposal Site - A site approved by the EPA for the disposal of asbestos-containing wastes.
16. Encapsulant - A liquid which can be applied to asbestos-containing materials and which controls the possible release of fibers from the materials.
17. Encapsulation - The use of an agent to seal the surface (bridging encapsulant) or penetrate the bulk (penetrating encapsulant) of the asbestos-containing material.
18. HEPA -High Efficiency Particulate Air - A type of filter which is 99.97% efficient at filtering particles of 0.3 micrometers in diameter.
19. HEPA Vacuum Equipment - Vacuuming equipment equipped with a HEPA filter in the exhaust outlet, and so designed and maintained that 99.97% of all particles of 0.3 micrometer in diameter in the inlet air are collected and retained.
20. Negative Pressure Respirators - Respirators which function by the wearer breathing in air through a filter.
21. NIOSH - National Institute of Occupational Safety and Heath.
22. the Owner's Representative - Authorized Consultants
23. Permissible Exposure Level (PEL) - A level of airborne fibers specified by OSHA as an occupational exposure standard for asbestos. It is 0.1 f/cc of air, eight-hour TWA, as measured by Phase Contrast Microscopy.
24. Repair - The restoration of damaged or deteriorated asbestos-containing material to intact condition.
25. Respirator Protection Program - A set of procedures and equipment required by OSHA if employees wear negative pressure respirators or if fiber levels are above the PEL.
26. Surfactant - Chemical wetting agent added to water to improve penetration, thus reducing the amount of water required for a given operation or area, and enhancing the effect of the water in reducing fiber release.
27. Thermal Systems Insulation - Material applied to pipes, fittings, boilers, breeching, tanks, ducts or other interior structural components to prevent heat loss or gain, or water condensation, or for other purposes.
28. Wet Cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths and mops or other cleaning tools that have been dampened with clean water and afterwards disposing of these cleaning tools as asbestos-contaminated waste.

I. Permits And Licenses:
1. The Contractor must maintain current licenses as required by applicable state or local jurisdictions for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

J. Regulations
1. This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specifications. This section also sets forth those notices and permits which are known to the Owner and which either must be applied for and received, or which must be given to governmental agencies before start of work.
2. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.
3. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor

is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state, and local regulations. The Contractor shall hold the Owner and the Owner's Representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of itself, its employees, or its Sub-Contractors.

4. Federal requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following regulations:
   a. U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:
      1) U.S. Department of Labor, OSHA, including, but not limited to:
         a) Occupational Exposure to Asbestos, Tremolite, Anthophyllite and Actinolite; Final Rules
            Title 29, Part 1910, Section 1001
            Part 1926, Section 1101 of the Code of Federal Regulations
         b) Respiratory Protection
            Title 29, Part 1910, Section 134 of the Code of Federal Regulations
         c) Construction Industry
            Title 29, Part 1926.1011, of the Code of Federal Regulation
         d) Access to Employee Exposure and Medical Records
            Title 29, Part 1910, Section 2 of the Code of Federal Regulations
         e) Hazard Communication
            Title 29, Part 1910, Section 1200 of the Code of Federal Regulations
         f) Specifications for Accident Prevention Signs and Tags
            Title 29, Part 1910, Section 145 of the Code of Federal Regulations
      2) U.S. Environmental Protection Agency (EPA) including, but not limited to:
         a) Asbestos Abatement Projects Rule
            40 CFR Part 762
            CPTS 62044, FRL 2843-9
            Federal Register, Vol. 50 No. 134, July 12,1985
            P28530-28540
         b) Regulation for Asbestos
            Title 40, Part 61, Subpart A of the Code of Federal Regulations
         c) National Emission Standard for Asbestos
            Title 40, Part 61, Subpart M (Revised Subpart B) of the Code of Federal Regulations
      3) State requirements which govern asbestos abatement work and/or hauling and disposal of asbestos waste materials.
      4) Contractor shall abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials including the following:
         a) American National Standards Institute (ANSI)
            1430 Broadway
            New York, NY 10018
            (212) 354-3300
         b) Fundamentals Governing the Design and Operation of Local Exhaust Systems Publication Z9.2-79
         c) Practices for Respiratory Protection Publication Z288.2-80
         d) American Society for Testing and Materials (ASTM)
            1916 Race Street
            Philadelphia, PA 19103
            (215) 299-5400
         e) Specification for Encapsulants for Friable Asbestos-Containing Building Materials
         f) Safety and Health Requirements Relating to Occupational Exposure to Asbestos

K. the Owner's Representative
   1. the Owner's Representative is authorized by the Owner to perform the following:
      a. Have free access to all asbestos work areas.
      b. To assist in interpretation of procedures.
      c. To advise on all provisions of the contract documents pertaining to the control of asbestos.
      d. To stop work if, in the course of performing their monitoring duties, an instance of substantial nonconformance with the contract documents is observed.
      e. To stop work if a situation presenting a health hazard to workers or the Owner's employees or occupants of the building is observed.
      f. To act as the Owner's liaison in technical matters involving the asbestos-related work.
      g. To perform air sampling inside and outside the asbestos work area during the project. The Contractor shall cooperate fully with the Owner's Representative, its agents and employees, and ensure cooperation of its workers during collection of air samples and work area inspections.
      h. the Owner's Representative role in advising the Owner on environmental health matters does not relieve the Contractor's obligation to comply with all applicable health and safety regulations. Air monitoring results generated by the Owner's Representative shall not be used by the Contractor to represent compliance with regulatory agency requirements for monitoring of worker's exposure to airborne asbestos, nor shall any other activity on the part of the Owner's Representative represent the Contractor's compliance with applicable health and safety regulations.

L. Pre-Construction Conference
   1. An initial progress meeting recognized as "Pre-Construction Conference" shall be held prior to start of any work. Contractor shall meet at project site, with General Superintendent, the Owner, the Owner's Representative, and other entities concerned with asbestos abatement work. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to all participants prior to convening Pre-Construction Conference.
   2. This is an organizational meeting, to review responsibilities and personnel assignments, to locate the containment and decontamination areas; and temporary facilities including power, light, water, etc.
   3. Submit waivers on forms, and executed in a manner acceptable to the Owner. Administrative requirements that must proceed or coincide with Contractor's submittal for final payment shall consist of the following:
      a. Completion of project closeout requirements.
      b. Completion of items specified for completion beyond time of Final Completion (regardless of whether special payment application was previously made).
      c. Assurance, satisfactory to the Owner, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
      d. Transmittal of required project construction records to the Owner.
      e. Landfill receipts for all asbestos-containing material.
      f. Proof, satisfactory to the Owner, that taxes, fees and similar obligations of Contractor have been paid.
      g. Removal of temporary facilities, services, surplus materials, rubbish and similar elements.
      h. Consent of surety for final payment.

M. Project Closeout
   1. Project closeout is the term used to describe certain collective project requirements that indicate completion of the work to be fulfilled near the end of the contract time. Also, in preparation for final acceptance of the work by the Owner, as well as, final payment to the Contractor and the normal termination of the Contract.
   2. Include supporting documentation for completion as indicated in these contract documents.
   3. Submit a statement on accounting of changes to the Contract Sum.
   4. Advise the Owner of pending insurance change-over requirements.

5. Submit specific warranties, workmanship and maintenance bonds, maintenance agreements, final certifications and similar documents.
6. Obtain and submit releases enabling the Owner's full, unrestricted use of the work area and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.
7. Results of the completed inspection will form the initial "punch-list" for final acceptance.
8. A complete record, certified by the testing laboratory, of all personal air monitoring results.
9. Complete the following cleaning operations as outlined in Paragraph “Decontamination Procedures” before requesting the Owner's Representative inspection for certification of Final Completion.
    a. Remove exposed labels in finished spaces which are not required as permanent labels on materials supplied as part of the work, except for "Asbestos", "Asbestos Free", or Thermal Insulation Labels specified elsewhere.
    b. Clean transparent materials, affected by the work including mirrors and window/door glass, to a polished condition, removing substances which are noticeably vision-obscuring materials. Replace broken glass and damaged transparent materials.
    c. Clean exposed hard-surfaced finishes affected by the work, to a dirt-free condition, free of dust, stains, films and similar distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition.
    d. Clean plumbing fixtures affected by the work to a sanitary condition, free of stains including those resulting from water exposure.
    e. Replace all HVAC filters using materials supplied by the Owner or clean non-replaceable filters after minimum of two days of operation of HVAC equipment.
    f. Clean light fixtures and lamps, which have been affected by the work so as to function with full efficiency. Replace lamps where inoperable.
    g. Repair any damage to wall, ceiling and floor surfaces caused by installation and removal of the polyethylene sheeting.

N. Personnel Protection
1. Prior to commencement of work, the workers shall be instructed and be knowledgeable in the areas described in Paragraph "Submittals and Notices" having to do with employees.
2. Worker Protection - shall comply with 29 CFR 1910.134 (Respiratory Protection).
    a. Because there is no known safe level of exposure to asbestos, it is prudent to reduce worker's exposures to as low a level as possible. Proper respiratory protection is critical in minimizing exposure.
    b. Workers shall be provided, as a minimum, with personally issued and marked respirators equipped with high efficiency particulate filters approved by NIOSH to be worn in the designated work area and/or whenever a potential exposure to asbestos exists. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
    c. No worker shall be exposed to levels greater than 0.01 f/cc as determined by the protection factor of the respirator worn and the work area fiber levels.
    d. Whenever powered purifying respirator protection is used, a sufficient supply of replacement batteries and HEPA filter cartridges shall be provided to the workers.
    e. Air monitoring required by OSHA is work of the Contractor and not covered in this specification. Contractor shall post, on a daily basis, results of the air monitoring results from the previous shift. A complete record, certified by the testing laboratory, of all personal air monitoring tests and results will be furnished to the Owner and the Owner's Representative prior to Contractor's Request for Final Payment.
    f. During encapsulation operations or usage of other organic base aerosols (e.g., spray glue, expanding foam), workers shall be provided with combination cartridges consisting of organic vapor and HEPA sections.

g. Workers shall be provided with sufficient sets of protective full-body clothing to be worn in the designated work area and/or whenever potential exposure to asbestos exists. Such clothing shall include, but not be limited to, full-body coveralls, headgear and gloves. Workers shall assure that hoods covering their hair are worn in the designated work areas at all times. Eye protection and hard hats shall be provided as required by applicable safety regulations. Eye protection shall be worn during encapsulation operations. Non-disposable type protective clothing and footwear shall be left in the work area until the end of the asbestos abatement work, at which time such items will be disposed of as asbestos waste.

h. Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent body contamination.

i. Protective clothing shall not be worn in lieu of street clothing outside the work area.

j. Visitor Clothing: The Contractor shall provide authorized visitors with suitable respirator, protective clothing, headgear, eye protection, and footwear as described herein, whenever they enter the work area.

3. Decontamination and Work Procedures: The decontamination and work procedures to be followed by workers shall be posted as described in these specifications.

4. Worker and Authorized Visitor Protection Procedures:

a. Each worker and authorized visitor shall, upon entering the job site, remove street clothes in a designated clean change area and put on a respirator with new filters and clean protective clothing before entering the work area.

b. The Contractor's employees shall perform a positive/negative respirator fit test each time it enters the work area. If leakage occurs, the respirator must be re-adjusted or replaced.

c. Workers shall maintain their respirators in a safe operating condition. The condition of respirators shall be checked daily.

d. Workers and visitors shall complete the decontamination procedures as outlined in the specification upon exiting the work area.

e. Workers shall not eat, drink, smoke, or chew gum or tobacco in or near the asbestos work areas.

f. Workers shall be fully protected with respirators and protective clothing immediately prior to the first disturbance of asbestos-containing or contaminated materials and until final cleanup is completed.

O. Air Monitoring

1. The airborne fiber counts outside the work area will be monitored to detect faults in the work area isolation such as contamination of the building outside of the work areas with airborne asbestos fibers, failure of filtration or rupture in the negative pressure system.
Should any of the above occur, the Contractor shall immediately cease asbestos abatement activities until the fault is corrected. Work shall not recommence until authorized by the Owner's Representative. In the case of mini-enclosures the Owner's Representative will monitor air in a remote location of the residence to determine the baseline of asbestos.

2. The airborne fiber counts in the work area will be monitored. The purpose of this air monitoring will be to detect airborne fiber counts which may significantly challenge the ability of the work area isolation procedures to protect the balance of the building or outside of the building from contamination by airborne fibers. In the case of mini-enclosures the Owner's representative may monitor air outside of several enclosures if they are in close proximity.

3. Contractor shall maintain an average airborne count inside the work area of less than 0.5 f/cc. If the fiber counts rise above this figure for any sample taken, revise work procedures to lower fiber counts. If the TWA fiber count for any work shift or eight-hour period exceeds 0.5 f/cc, stop all work, leave pressure differential system in operation and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

4. If airborne fiber counts exceed 1.0 f/cc for any period of time cease all work until fiber counts fall below 0.5 f/cc and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

5. If any air sample taken outside of the work area exceeds the 0.01 f/cc of air, Contractor shall immediately and automatically stop all work. If this air sample was taken inside the building and outside of critical barriers around the work area, immediately erect new critical barriers to isolate the affected area from the balance of the building. Erect Critical Barriers at the next existing structural isolation of the involved space (e.g., wall, ceiling, and floor). Leave Critical Barriers in place until completion of work and insure that the operation of the negative pressure system in the work area results in a flow of air from the balance of the building into the affected area.
6. If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a temporary decontamination facility consisting of a shower room and changing room. After cleaning and decontamination of the affected area remove the shower room and leave the changing room in place as an air lock.
7. After certification of visual inspection in the work area, remove critical barriers separating the work area from the affected area. Final air samples will be taken within the entire area.
8. The following procedure will be used to resolve any disputes regarding fiber types when a project has been stopped due to excessive airborne fiber counts. "Airborne Fibers" referred to above include all fibers regardless of composition as counted in the Phase Contrast Microscopy (PCM) NIOSH 7400 Method procedures. If work has stopped due to high airborne fiber counts, air samples will be secured in the same area by the Owner's Representative for analysis by electron microscopy. "Airborne fibers" counted in samples analyzed by Scanning or Transmission Electron Microscopy (TEM) shall be only asbestos fibers, but of any diameter and length. Subsequent to analysis by Electron Microscopy the number of airborne fibers shall be determined by multiplying the number of fibers, regardless of composition, counted by the PCM NIOSH 7400 Method procedure by a number equal to asbestos fibers counted divided by all fibers counted in the electron microscopy analysis.
9. If electron microscopy is used to arrive at the basis for determining airborne fiber counts in accordance with the above paragraph, and if the average of airborne asbestos fibers in all samples taken exceeds 0.1 f/cc, or if any one sample exceeds 0.2 f/cc, then the cost of such analysis will be born by the Contractor, at no additional cost to the Owner.
10. the Owner's Representative will secure at least the following air samples to establish a base line before start of work involving large enclosures:

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM
Each Work Area	1	PCM	0.01	1,900	2-16
Outside Each Work Area	1-3	PCM	0.01	1,900	2-16

11. Base Line is an action level expressed in f/cc, which is ten percent greater than the largest of the following:
    a. Average of the samples collected on cellulose ester filters outside each work area.
    b. Average of the samples collected on cellulose ester filters outside the building.
    c. 0.01 fibers per cubic centimeter.
12. Daily: From start of work of Paragraph "Temporary Enclosure" through the work of Paragraph "Project Decontamination," the Owner may be taking the following samples on a daily basis. The location of each air sample will be determined by the Owner's Representative.
    a. Baseline
    b. Work Area
13. For larger enclosures samples will be collected on 25 mm cassettes with the following filter medial:
    PCM: 0.8 micrometer mixed cellulose ester.

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM

Each Work Area	2	PCM	0.01	1,900 as required by conditions	2-16
Outside Each Work Area Critical Barrier	1	PCM	0.01	1,900	2-16
Clean Room	1	PCM	0.01	1,900	2-16
Equip Decon	1	PCM	0.01	1,900	2-16

14. Additional samples may be taken at the Owner or the Owner's Representative discretion. If airborne fiber counts exceed allowed limits, additional samples will be taken as necessary to monitor fiber levels.
15. The services of a testing laboratory will be employed by the Owner to perform laboratory analysis of the air samples. Samples will be sent daily so that verbal reports on air samples can be obtained in a timely manner. A complete record, certified by the testing laboratory, of all air monitoring tests and results will be furnished to the Owner's Representative, the Owner and the Contractor.
16. Air samples may be analyzed on site by the Owner's Representative, if they are to be analyzed by the NIOSH 7400 Method.
17. Cellulose ester filters will be analyzed using the PCM NIOSH 7400 Method. Thus analysis will be carried out at a laboratory located off the job site.
18. At the completion of the work in occupied areas and prior to the dismantling of the isolation system, final air clearance will be conducted by the Owner's Representative.
19. Decontamination of the work area will be considered complete when all samples indicate fiber levels are less than 0.0l f/cc of air as analyzed by PCM NIOSH 7400 Method or an average of less than 70 structures per square millimeter of filter area as analyzed by TEM; Level II AHERA Method.
20. The Contractor may conduct its own air monitoring and laboratory testing. If it elects to do this the cost of such air monitoring and laboratory testing shall be included in the Contract Sum.

P. Equipment Removal Procedures
1. Clean all external surfaces of contaminated waste containers and equipment thoroughly by wet sponging or HEPA vacuuming before moving such items into the equipment decontamination enclosure system washroom for final cleaning and removal to uncontaminated areas. Ensure that personnel do not leave the work areas through the equipment decontamination enclosure system.

Q. Disposal Activities
1. It is the responsibility of the Contractor to comply with current federal, state and local regulations concerning the waste handling, transportation, and disposal of asbestos-containing material (ACM) and accompanying solvents or residues.
2. The Contractor will document actual disposal of the waste at the designated landfill by completing Disposal Certificate or submitting proof of landfill receipt.

1.2 PRODUCTS

A. Materials
1. All Contractor's equipment delivered to the site shall be free of asbestos contamination.
2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
3. Damaged or deteriorating materials shall not be used and shall be removed from the premises. Materials that become contaminated shall be disposed of in accordance with applicable regulations.

4. Polyethylene flame retardant sheet of 6-mil thickness shall be used unless otherwise specified. Polyethylene sheeting shall be sized to minimize the frequency of joints. Polyethylene sheeting must satisfy the National Fire Prevention Association Standard 701, "Small Scale Fire Test for Flame Resistant Textile and Film."
5. Adhesive tape shall be capable of sealing joints of adjacent sheets of polyethylene and for use in attachment of polyethylene sheet to finished or unfinished surfaces of similar materials and shall be capable of adhering under dry and wet conditions, including use of amended water. Contractor shall use adhesive tape compatible with finished surfaces.
6. Protective devices such as, but not limited to, disposable clothing, respirators, gloves, hard hats, etc. shall be used.
7. Wetting agent shall be a mixture of 50/50 polyoxyethylene ether and polyglycol ester or equivalent commercial product.
8. Encapsulant materials shall be the bridging and penetrating type and conform with the following characteristics:
    a. Encapsulants shall not be solvent-based or utilize a hydrocarbon in the liquid in which the solid parts of the encapsulant are suspended.
    b. Encapsulant shall not be flammable.
9. A non-hardening lagging sealer for enclosing and sealing raw exposed edges and surfaces of asbestos-containing materials.
10. Pre-mixed or job mixed insulating plaster manufactured for use on plumbing equipment shall be used when repairing damaged thermal insulation material.
11. Non-woven fibrous glass mat and open weave glass fiber mat cloth for repair of thermal systems insulation.
12. Fire retardant sealant shall prevent fire, smoke, water and toxic fumes from penetrating through sealants. Sealant shall have a flame spread, smoke and fuel contribution of zero, and shall be ASTM and Underwriter's Laboratory (UL) rated for three hours for standard method of fire test for fire stop systems.

B. Tools And Equipment
1. Provide suitable tools for repair and encapsulation of asbestos-containing materials and for removal of asbestos-containing materials that are beyond repair. Wire brushes shall not be used as a means of removing or cleaning asbestos-containing materials from surfaces, if they are used as the surface is being sprayed with water or amended water.
2. Provide sufficient number of HEPA-filtered vacuum cleaners equipped with pick-up adapters, steel floor wands, crevice tools, and carpet tools.
3. Airless sprayers capable of spraying amended water shall be provided in sufficient number to allow continuous uninterrupted work.
4. Asbestos filtration devices shall utilize high efficiency particulate air (HEPA) filtration systems.
5. Transportation equipment, as required, shall be suitable for loading, temporary storage, and unloading of contaminated waste without exposure to persons or property, and shall be quiet in motion if used within the building.

1.3 EXECUTION

A. Safety Procedures For Power And Lighting
1. The use of wet methods for removal, repair, encapsulation or cleaning procedures increases the potential for electrical shock when working around electrical panels, conduit, light fixtures, alarm systems, junction boxes, transformers, etc. In coordination with the Owner, de-energize as much electrical equipment as possible to prevent electrical shock to employees performing the work. The Contractor shall use the following precautions:
    a. Use non-conductive tools and vacuum attachments.
    b. Utilize "hot line" covers over energized cables and power lines when possible.

c. Ensure all electrical equipment in use is properly grounded before the job starts. Check outlets, wiring, extension cords and power pickups.
d. Avoid stringing wiring across floors. Elevate wiring if possible.
e. Ensure electrical outlets are tightly sealed and taped to avoid water spray.
f. Determine operating voltages of equipment and lines before working on or near energized parts.
g. Energized parts must be insulated or guarded from employee contact and other conductive objects. Extension cords must be three-wire type and connected to a Ground Fault Interrupter (GFI) circuit.
h. Lock or secure de-energized circuits at panel and post warning signs.
i. Seal heating vents with two layers of polyethylene sheeting prior to the start of work. The Contractor shall repair any damage caused by Contractor's operations to duct work, grilles, dampers, louvers or HVAC equipment at the completion of the work at Contractor's expense. Coordinate all lock out and or de-energizing with the Owner.

B. Temporary Facilities
1. Use qualified tradesmen for installation of temporary services and facilities. Locate temporary services and facilities where they will serve the entire project adequately and result in minimum interference with the performance of the work and operations of the building. Coordinate all installations and shut downs with building owner.
2. Relocate, modify and extend services and facilities as required during the course of work so as to accommodate the entire work of the project.
3. Provide new or used materials and equipment that are undamaged and in serviceable condition. Provide only materials and equipment that are recognized as being suitable for the intended use, by compliance with appropriate standards.
4. During the erection and/or moving of scaffolding, care must be exercised so that the polyethylene floor covering is not damaged.
5. Clean, as necessary, debris from non-slip surfaces.
6. At the completion of abatement work, clean all construction aids within the work area, wrap in one layer of 6-mil polyethylene sheet and seal before removal from the work area.
7. Temporary water service connections to the Owner's water system shall include back flow protection. Valves shall be temperature and pressure rated for operation of the temperatures and pressures encountered.
8. Employ heavy-duty abrasion-resistant hoses with a pressure rating 50 percent greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit. Provide fittings as required to allow for connection to existing wall hydrants or spouts, as well as temporary water heating equipment, branch piping, showers, shut-off nozzles and equipment.
9. Electrical Services shall comply with applicable NEMA, NECA and UL standards and governing regulations for materials and layout of temporary electric service.
10. Provide a weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity, and power characteristics to accommodate performance of work during the construction period. Install temporary lighting adequate to provide sufficient illumination for safe work and traffic conditions in every area of work.
11. Provide receptacle outlets equipped with ground fault circuit interrupters, reset button and pilot light, for plug-in connection of power tools and equipment.
12. Use only grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Use single lengths or use waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas of work. All cords shall be elevated off the floor inside the containment area.
13. Temporary wiring in the work area shall be type UL non-metallic sheathed cable located overhead and exposed for surveillance. Do not wire temporary lighting with plain, exposed (insulated) electrical conductors. Provide liquid tight enclosures or boxes for wiring devices.

14. Provide Type "A" fire extinguishers for temporary offices and similar spaces where there is minimal danger of electrical or grease-oil-flammable liquid fires. In other locations provide type "ABC" dry chemical extinguishers, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.
15. Use of the Owner's existing toilet facilities, as indicated, will be permitted, so long as these facilities are properly cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore these facilities to the condition prevalent at the time of initial use. All provisions of these specifications regarding leaving the work area must be met.
16. When mini-enclosures area being used all of the requirements above will be enforced by the Owner's Representative. The construction and set-up of the mini-enclosures may be done by the Abatement Contractor.

C. Pressure Differential System
1. Before start of work Contractor shall submit design of pressure differential system to the Owner's Representative for review. Do not begin work until system has been approved by the Owner's Representative. Include in the submittal the following:
   a. Number of pressure differential machines required and the calculations necessary to determine the number of machines.
   b. Description of projected air-flow within work area and methods required to provide adequate air flow in all portions of the work area.
2. If the enclosure is not a mini-enclosure, the Contractor must supply the required number of asbestos air filtration units to the site in accordance with these specifications. Each unit shall include the following:
   a. Cabinet constructed of steel or other durable materials able to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Cabinet shall be factory sealed to prevent asbestos-containing dust from being released during use, transport, or maintenance. Access to and replacement of all air filters shall be from intake end. Unit shall be mounted on casters or wheels.
   b. Rate capacity of fan according to useable air-moving capacity under actual operating conditions. Use centrifugal-type fan.
   c. The final filter shall be the HEPA type. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame.
   d. A continuous rubber gasket shall be located between the filter and the filter housing to form a tight seal.
   e. Provide HEPA Units that are individually tested and certified on site by an independent testing agency to have an efficiency of not less than 99.97 percent when challenged with 0.3 m dioctylphthlaate (DOP) particles when tested in accordance with Military Standard Number 2182 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions.
   f. Pre-filters, which protect the final filter by removing the larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. The first-stage pre-filter shall be a low-efficiency type (e.g., for particles 10 microns and larger). The second-stage (or intermediate) filter shall have a medium efficiency (e.g., effective for particles down to 5 microns). Pre-filters and intermediate filters shall be installed either on or in the intake grid of the unit and held in place with special housings or clamps.
   g. Each unit shall be equipped with a Magnahelic gauge or manometer to measure the pressure drop across filters and indicate when filters have become loaded and need to be changed. A table indicating the useable air-handling capacity for various static pressure readings on the Magnahelic gauge shall be affixed near the gauge for reference, or the Magnahelic reading indicating at what point the filters should be changed, noting Cubic Feet per Minute (CFM) air delivery at that point. Provide units equipped with an elapsed time meter to show the total accumulated hours of operation.

h. The unit shall have an electrical (or mechanical) lockout to prevent fan from operating without a HEPA filter. Units shall be equipped with automatic shutdown system to stop fan in the event of a major rupture in the HEPA filter or blocked air discharge. Warning lights are required to indicate normal operation, too high a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge).

i. Electrical components shall be approved by the National Electrical Manufacturers Association (NEMA) and Underwriters' Laboratories (UL). Each unit shall be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet shall be grounded.

j. If a mini-enclosure is used the air filtration unit may be a HEPA filtered vacuum with a flow rate of at least 100 cubic feet per minute (CFM).

3. Provide a fully operational pressure differential system within the work area maintaining continuously a pressure differential across work area enclosures of 0.02 inches of water for glove bag operations and mini-containments**.** Demonstrate to the Owner's Representative the pressure differential by use of pressure differential meter or a manometer, before disturbance of any asbestos-containing materials. In the case of a mini-enclosure visual evidence of pressure differential through the use of a smoke generation tube shall be sufficient as in paragraph C.13 of this section.
4. Continuously monitor and record the pressure differential between the work area and the building outside of the work area.
5. Provide fully operational negative pressure systems supplying a minimum of one air change every ten minutes (six changes per hour), less in the instance of a mini-enclosure. Determine the volume in cubic feet of the work area by multiplying floor area by ceiling height. Determine total ventilation requirement in cubic feet per minute (cfm) for the work area by dividing this volume by the air change rate.
6. Ventilation Required (CFM) = Volume of work area (cu. ft.)/10 min.
7. Determine number of units needed to achieve ten-minute change rate by dividing the ventilation requirement (CFM) above capacity of exhaust unit(s) used. Capacity of a unit for purposes of this section is the capacity in cubic feet per minute with fully loaded filters (pressure differential which causes loaded filter warning light to come on) in the machines labeled operating characteristics.
8. Add one additional unit as a backup in case of equipment failure or machine shutdown for filter changing.
9. Locate exhaust unit(s) so that makeup air enters work area primarily through decontamination facilities and traverses work area as much as possible. This may be accomplished by positioning the unit(s) at a maximum distance from the worker access opening or other makeup air sources.
10. Vent to outside of building, unless authorized in writing by the Owner's Representative.
11. Each unit shall be serviced by a dedicated minimum 115v-20A circuit with overload device tied into an existing building electrical panel which has sufficient spare capacity to accommodate the load of all pressure differential units connected. Dedication of an existing circuit may be accomplished by shutting down existing loads on the circuit.
12. Test pressure differential system before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, start the unit(s) (one at a time). Demonstrate operation and testing of pressure differential system to the Owner's Representative.
13. Demonstrate of operations of the pressure differential system to the Owner's Representative will include, but not be limited to, the following:
    a. Plastic barriers and sheeting move lightly in toward work area.
    b. Curtain of decontamination units move lightly in toward work area.
    c. There is a noticeable movement of air through the decontamination unit. Use stroke tube to demonstrate air movement from clean room, and from equipment room to work area.
    d. Use smoke tubes to demonstrate a positive motion of air across all area in which work is to be performed.

e. Use a differential pressure meter or manometer to demonstrate a pressure difference of at least 0.02 inches (as allowed) of water across every barrier separating the work area from the balance of the building or outside. This is not required in the case of a mini enclosure.

14. Start exhaust units before beginning work (before any asbestos-containing material is disturbed). After abatement work has begun, run units continuously to maintain a constant negative pressure until decontamination of the work area is complete. Do not turn off units at the end of the work shift or when abatement operations temporarily stop.
15. Do not shut down pressure differential system during encapsulating procedures, unless authorized by the Owner's Representative in writing. Start abatement work at a location farthest from the exhaust units and proceed toward them. If an electric power failure occurs, immediately stop all abatement work and do not resume until power is restored and exhaust units are operating again.
16. At completion of abatement work, allow exhaust units to run as specified to remove airborne fibers that may have been generated during abatement work and cleanup and to purge the work area with clean makeup air. The units may be required to run for a longer time after decontamination, if dry or only partially wetted asbestos material was encountered during any abatement work. In the case of a mini-enclosure the vacuum may be removed and the entrance sealed following encapsulation until the clearance sample is collected.
17. Prior to final air test, remove pre-filter and wipe out inside lip of negative air machine.
18. When a final inspection and the results of final air tests indicate that the area has been decontaminated, exhaust units may be removed from the work area. Before removal from the work area, remove and properly dispose of pre-filter, and seal Intake to the machine with 6-mil polyethylene to prevent environmental contamination from the filters.

D. Work Area Preparation

1. The work area is the location where asbestos-abatement work occurs. It is a variable of the extent of work of the contract. It may be a portion of a room, a single room, or a complex of rooms. A "work area" is considered contaminated during the work, and must be isolated from the balance of the building, and decontaminated at the completion of the asbestos-control work.
2. Pre-clean fixed objects, walls and floor surfaces within the proposed work areas using HEPA filtered vacuum equipment and wet cleaning methods as appropriate.
3. Seal all openings, supply and exhaust vents, and convectors within ten feet of the work area with 6-mil polyethylene sheeting secured and completely sealed with plastic adhesion tape.
4. Contact fire control agencies to review procedures prior to start of work.
5. Provide flame resistant polyethylene sheeting that conforms to requirements set forth by the National Fire Protection Association Standard 701, Small Scale Fire Test for Flame-resistant Textiles and Films. Provide largest size possible to minimize seams, four- or six- mils thick, frosted or black.
6. Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene and supporting surface.
7. Completely isolate the work area from other parts of the building so as to prevent asbestos-containing dust or debris from passing beyond the isolated area. Should the area beyond the work area(s) become contaminated with asbestos-containing dust or debris as a consequence of the work, clean those areas in accordance with the procedures indicated in Paragraph "Decontamination Procedures." All such required cleaning or decontamination shall be performed at no additional cost to the Owner.
8. Place all tools (i.e., scaffolding, staging) necessary for the work in the area to be isolated prior to erection of plastic sheeting temporary enclosure.
9. Disable ventilation systems or any other system bringing air into or out of the work area. Disable system by disconnecting wires, removing circuit breakers, by lockable switch or other positive means that will prevent accidental premature restarting of equipment.
10. Remove and dispose of all electrical and mechanical items, such as lighting fixtures, clocks, diffusers, registers, escutcheon plates, etc., which cover any part of the surface on which work is to be performed.

11. All general construction items such as cabinets, casework, doors and window trim, moldings, ceilings, trim, etc., which cover the surface of the work as required to prevent interference with the work. To be performed by the Owner: clean, decontaminate and reinstall all such materials, upon completion of all removal work with materials, finishes, and workmanship to match existing installations before start of work.
12. Permit Access to the work area only through the Decontamination Unit. All other means of access shall be closed off and sealed and warning signs displayed on the clean side of the sealed access.
13. Provide Warning Signs at each visual and physical barriers reading as follows in both English and Spanish:

Legend	Notation
KEEP OUT	3" Sans Serif Gothic or Block
BEYOND THIS POINT	1" Sans Serif Gothic or Block
ASBESTOS ABATEMENT WORK	1" Sans Serif Gothic or Block
IN PROGRESS	1" Sans Serif Gothic or Block
BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH	14 Point Gothic

14. Alternate methods of containing the work area may be submitted to the Owner's Representative for approval. Do not proceed with any such method(s) without prior written approval of the Owner's Representative.
15. Individually seal all ventilation openings (supply and exhaust), lighting fixtures, clocks, doorways, windows, convectors and speakers, and other openings into the work area with plastic adhesion tape alone or with polyethylene sheeting at least 4-mil in thickness, taped securely in place with plastic adhesion tape. Maintain seal until all work including Project Decontamination is completed. Take care in sealing off lighting fixtures to avoid melting or burning of sheeting.
16. Provide sheet plastic barriers at least 6-mil in thickness as required to completely seal openings from the work area into adjacent areas. Seal the perimeter of all sheet plastic barriers with plastic adhesion tape or spray cement.
17. Where applicable, construct framing of the containment out of fire treated wood or aluminum studs. Mini-enclosure frames may be constructed of Polyvinyl Chloride (PVC) tubing.
18. Cover all walls in work area extending to the underside of the ceiling grid system with one layer of polyethylene sheeting, at least 6-mil in thickness, mechanically supported and sealed with plastic adhesion tape or spray-glue in the same manner as "Critical Barrier" sheet plastic barriers. Tape all joints with plastic adhesion tape. Contractor shall be responsible for repair of damaged wall finishes.
19. Cover floor with two layers of 6-mil polyethylene sheeting (exclude for floor tile and adhesive).
20. Provide Pressure Differential System per Paragraph “Pressure Differential System.”
21. If the enclosure barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, then add the affected area to the work area, enclose it as required by this section of the specification and decontaminate it as described in Paragraph “Decontamination Procedures.”
22. Establishing a Mini-Containment area:
    a. Establish work area so that unauthorized entry is prevented; Construct a two-compartment fire treated wood frame around work area; install one layer 6-mil polyethylene sheeting to structural members and two layers 6 mil polyethylene sheeting to the floor. Exception: no floor required if mini-containment is being constructed to perform a floor tile activity. Seal all edges to wall, ceiling, and floor surfaces with duct tape. Install viewing inspection windows, where feasible.
    b. Seal all penetrations with duct tape such as pipes, electrical conduit, or ducts contained within the mini-containment.

c. Install triple 6-mil polyethylene flaps at both doorways. Place portable sprayer with clean water, disposable towels, and pre-labeled disposal bag in air lock.
d. Install appropriate signs on outside of mini-containment area.
e. Install HEPA vacuum; extend hose into mini-containment area for general vacuuming, negative air, and cleaning of disposal suit.
f. Accumulate all loose materials for disposal. Place in approved container. Apply appropriate labels. Adequately wet clean all wall, floor, tool and equipment surfaces.
g. Abatement worker must wear two disposable suits. Remove outer suit in work area and place in a plastic bag. Enter air lock.
h. In air lock, wet wipe respirator and wash hands with clean water. Remove respirator and place in a clean plastic bag. Proceed to remote shower unit where inner suit may be removed.

E. Worker Protection
1. This section describes the equipment and procedures required for protecting workers against asbestos contamination and other work place hazards except for respiratory protection.
2. Respiratory Protection is specified in Paragraph “Respiratory Protection.”
3. Train in accordance with EPA’s Model Accreditation Plan, 40 CFR 763 - Asbestos, all workers in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. Include but do not limit the topics covered in the course to the following:
   a. Methods of recognizing asbestos.
   b. Health effects associated with asbestos.
   c. Relationship between smoking and asbestos in producing lung cancer.
   d. Nature of operations that could result in exposure to asbestos.
4. Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

   Engineering controls
   Work practices
   Respirators
   Housekeeping procedures
   Hygiene facilities
   Protective clothing
   Decontamination procedures
   Emergency procedures
   Waste disposal procedures
   Appropriate work practices for the work
   Requirements of medical surveillance program
   Review of OSHA 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos
   Pressure differential systems
   Work practices including hands on or on job training
   Personal decontamination procedures
   Air monitoring, personal and area

5. Provide medical examinations for all workers who may encounter an airborne fiber level of 0.1 f/cc or greater for an 8 hour time weighted average. In the absence of specific airborne fiber data, provide medical examination for all workers who will enter the work area for any reason. Examination shall, at minimum, meet OSHA requirements as set forth in 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos. In addition, provide an evaluation of the individual’s ability to work in environments capable of producing heat stress in the worker.
6. Before start of work Contractor shall submit the following to the Owner's Representative for review. Do not start work until receipt of the Owner’s Representative.

a. An original signed copy of the Certificate of Worker's Acknowledgement found at the end of this specification, for each worker who is to be at the job site or enter the work area.
b. Courses outline or name of institution providing the worker training course.
c. Report from medical examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area.

7. Provide disposable full-body coveralls and disposable head covers, and require that they be worn by all workers in the work area. Provide a sufficient number for all required changes, for all workers in the work area.
8. Provide work boots with non-skid soles, and where required by OSHA, foot protectives, for all workers. Provide boots at no cost to workers. Paint uppers of all boots red with water proof enamel. Do not allow boots to be removed from the work area for any reason, after being contaminated with asbestos-containing material. Dispose of boots as asbestos contaminated waste at the end of the work.
9. Provide head protectives (hard hats) as required by OSHA for all workers, and provide four spares for use by the Owner's Representative, and the Owner. Label hats with same warning labels as used on disposal bags. Require hard hats to be worn at all times that work is in progress that may potentially cause head injury. Provide hard hats with plastic strap type suspension. Require hats to remain in the work area throughout the work. Thoroughly clean, decontaminate and bag hats before removing them from work area at the end of the work.
10. Provide eye protectives (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity which may potentially cause eye injury.
11. Provide work gloves to all workers and require that they be worn at all times in the work area. Do not remove gloves from work area. Dispose of gloves as asbestos contaminated waste at the end of the work.
12. Respirators, disposable coveralls, head covers, and footwear covers shall be provided by the contractor for the Owner, the Owner's Representative, and other authorized representatives who may inspect the job site.
13. Provide worker protection as required by the most stringent OSHA and/or EPA standards applicable to the work. The following procedures are minimums to be adhered to regardless of fiber count in the work area.
14. Each time work is entered, remove <u>all</u> street clothes in the changing room of the Personnel Decontamination Unit and put on new disposable coverall, new head cover, and a clean respirator. Proceed through shower room to equipment room and put on work boots.
15. In the event a mini-enclosure is used refer to Paragraph "Work Area Preparation" for personal decontamination procedures.

F. Respiratory Protection

1. Instruct and train each worker involved in asbestos abatement or maintenance and repair of friable asbestos-containing materials in proper respiratory use and require that each worker always wear a respirator, properly fitted on the face in the work area from the start of any operation which may cause airborne asbestos fibers until the work area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the work place or as required for other toxic or oxygen-deficient situations encountered.
2. Except to the extent that more stringent requirements are written directly into the Contract Documents, the following regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies were bound herewith. Where there is a conflict in requirements set forth in these regulations and standards meet the more stringent requirement.
   a. OSHA - U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Standards 29 CFR 1910, Section 1001 and Section 1910.134.29 CFR 1926.
   b. ANSI - American National Standard Practices for Respiratory Protection. ANSI Z88.2-1980.
   c. NIOSH - National Institute for Occupational Safety and Health.

d. MSHA - Mine Safety and Health Administration.

G. Type Of Respiratory Protection Required

1. Provide Respiratory Protection as indicated in paragraph below. Where paragraph below does not apply, determine the proper level of protection by dividing the expected or actual airborne fiber count in the work area by the "protection factors" given below. The level of respiratory protection which supplies an airborne fiber level inside the respirator, at the breathing zone of the wearer, at or below 0.01 fibers/cubic centimeter is the minimum level of protection allowed.
2. Eight-hour Time Weighted Average (TWA) of asbestos fibers to which any worker may be exposed shall not exceed 0.1 fibers/cubic centimeter.
3. For purposes of this section fibers are defined as all fibers regardless of composition as counted in the OSHA Reference Method (ORM), NIOSH P&CAM 239 or 7400 procedure, or asbestos fibers of any size as counted using either a scanning or transmission electron microscope.
4. Require that respiratory protection be used at all times that there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental.
5. Require that a respirator be worn by anyone in a work area at all tunes, regardless of activity, during a period that starts with any operation which could cause airborne fibers until the area has been cleared for re-occupancy.

H. Respiratory Protection Factor

Respirator Type	Protection Factor
Air purifying: Negative pressure respirator High efficiency filter Half facepiece	10
Air purifying: Negative pressure respirator High efficiency filter Full facepiece	50
Powered-air purifying (PAPR): Positive pressure respirator High efficiency filter Half or Full facepiece	100
Type C supplied air: Positive pressure respirator continuous-flow Half or full facepiece	100
Type C supplied air: Positive pressure respirator pressure demand Full facepiece	1000
Type C supplied air: Positive pressure respirator pressure demand Full facepiece Equipped with an auxiliary positive pressure Self-contained breathing apparatus (SCBA)	over 1000
Self-contained breathing apparatus (SCBA): Positive Pressure respirator	over 1000

Pressure demand
Full facepiece

I. Air Purifying Respirator
1. Provide half face or full face type respirators. Equip full-face respirators with a nose cup or other anti-fogging device as would be appropriate for use in air temperatures less than 32 degrees Fahrenheit.
2. Provide, at a minimum, HEPA type filters labeled with NIOSH and MSHA certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-Containing Dusts and Mists" and color coded in accordance with ANSI Z228.2 (1980). In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH/MSHA Certification.
3. Supply with a sufficient quantity of respirator filters approved for asbestos, so that workers can change filters during the work day. Require that respirators be wet-rinsed, and filters discarded, each time a worker leaves the work area. Require that new filters be installed each time a worker re-enters the work area. Store respirators and filters at the job site in the changing room and protect totally from exposure to asbestos prior to their use. Do not use single use, disposable or quarterface respirators.

J. Powered Air Purifying Respirator (PAPR)
1. Provide full-facepiece type respirators. Provide nose-cups for full-facepiece respirators. Provide, at a minimum, HEPA type cartridges approved by NIOSH/MSHA and certified for use in atmospheres containing asbestos dusts.
2. Provide, at a minimum, one extra battery pack for each respirator so that one can be charging while one is in use.
3. Provide non-cloth belts capable of being decontaminated in shower.
4. Supply with a sufficient quantity of high efficiency respirator filters approved for asbestos so that workers can change filters at any time that flow through the face piece decreases to the level at which the manufacturer recommends filter replacement. Require that regardless of flow, filter cartridges be replaced after 40 hours of use. Require that HEPA elements in filter cartridges be protected from wetting during showering. Require entire exterior housing of respirator including blower unit, filter cartridges, hoses, battery pack, face mask, belt, and cords to be washed each time a worker leaves the work area. Caution should be used to avoid shorting battery pack during washing.

K. Required Respiratory Protection
1. Regardless of airborne fiber levels, require the following minimum level of respiratory protection:
   a. Half-face air purifying respirators may be used during set-up of the containment and removal of the material so long as fiber counts inside the respirator do not exceed .01 f/cc fibers per cubic centimeter.

L. Decontamination Units -Three-Stage
1. Provide a Personnel Decontamination Unit consisting of a serial arrangement of rooms or spaces, Changing Room, Shower Room, Equipment Room adjacent to each full containment area.
2. Require all persons without exception to pass through this decontamination unit for entry into and exiting from the work area for any purpose. Do not remove equipment or materials through Personnel Decontamination Unit.
3. Changing (Clean) Room:
   a. Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing.
   b. Locate so that access to work area from changing room is through shower room.

c. Separate changing room from the building by a double-sheeted polyethylene flapped doorway.
d. Provide sub-panel at changing room to accommodate all removal equipment. Power sub-panel directly from a building electrical panel. Connect all electrical branch circuits in decontamination unit and particularly any pumps in shower room to a ground-fault circuit protection device.

4. Shower Room:
   a. Provide a completely water tight operational shower to be used for transit by cleanly dressed workers heading for the work area from the changing room, or for showering by workers headed out of the work area after undressing in the equipment room.
   b. Construct room by providing a shower pan and two shower walls in a configuration that will cause water running down walls to drip into pan. Install a freely draining wood floor in shower pan at elevation of top of pan.
   c. Separate this room from rest of building, drying room and airlock with airtight walls fabricated of 6-mil polyethylene.
   d. Provide splash proof entrances to Drying Room and Airlock.
5. Equipment Room (contaminated area):
   a. Require work equipment, footwear and additional contaminated work clothing to be left here. This is a change and transit area for workers. Separate this room from the work area by a 6-mil polyethylene flap doorway.
   b. Separate this room from the rest of the building, the shower room and work area with air tight walls fabricated of 6-mil polyethylene.
6. Clean Room: Provide Clean Room to isolate the holding room from the building exterior.
7. Load-out Area:
   a. The load-out area is the transfer area from the building to a truck or dumpster.
   b. Wet wipe bags before they are passed through the equipment decon-chamber.
   c. When cleaning is complete pass items into holding room. Close all doorways except the doorway between the holding room and the Clean Room.
   d. Workers from the area outside the containment area enter holding area and remove decontaminated equipment and/or containers for disposal.
   e. Require these workers to wear full protective clothing and appropriate respiratory protection.
   f. At no time is a worker from an uncontaminated area to enter the enclosure when a removal worker is inside.
   g. Post an approximately 20 inch x 14 inch manufactured caution sign at each entrance to the work area displaying the following legend with letter sizes and styles of a visibility required by OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos.

LEGEND
DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED
IN THIS AREA

   h. Provide spacing between respective lines at least equal to the height of the respective upper line.
   i. Additional Signage: Shall also be posted in accordance with OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA
DANGER
ASBESTOS
CANCER AND LUNG HAZARD
KEEP OUT

j. Post an approximately 10 inch by 14 inch manufactured sign at each entrance to each work area displaying the following legend with letter sizes and styles of a visibility at least equal to the following:

LEGEND	NOTATION
No Food, Beverages or Tobacco Permitted	3/4 inch Block
All Persons Shall Don Protective Clothing (Coverings) Before Entering the Work Area	3/4 inch Block
All Persons Shall Shower Immediately After Leaving Work Area and Before Entering the Changing Area	3/4 inch Block

M. Decontamination Procedures

1. Contractor shall require all workers and visitors to adhere to the following personal decontamination procedures whenever they leave the work area:

a. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area.
b. When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the Equipment Room.
c. Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
   1) Thoroughly wet body including hair and face. If using a PAPR, hold blower unit above head to keep canisters dry.
   2) With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.
   3) Take a deep breath, hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breathe.
   4) Carefully wash face-piece of respirator inside and out.
d. If using PAPR, shut down in the following sequence, first cap inlets to filter cartridges, then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack as this will short out and destroy battery.
   1) Shower completely with soap and water.
   2) Rinse thoroughly.
   3) Rinse shower room walls and floor prior to exit.
   4) Proceed from shower to changing room and change into street clothes or into new disposable work items.

e. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area with a half or full face cartridge type respirator:
   1) When exiting area, remove disposable coveralls, disposable headcovers, and disposable footwear covers or boots in the equipment room.
   2) Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator and filters to avoid asbestos fibers while showering. The following procedure is required as a minimum:
   3) Thoroughly wet body from neck down.
   4) Wet hair as thoroughly as possible without wetting the respirator filter if using an air purifying type respirator.
   5) Take a deep breath, hold it and/or exhale slowly, complete wetting of hair, thoroughly wetting face, respirator and filter (air purifying respirator). While still holding breath, remove respirator and hold it away from face before starting to breath.
   6) Dispose of wet filters from air purifying respirator.
   7) Carefully wash facepiece of respirator inside and out.
   8) Shower completely with soap and water.
   9) Rinse thoroughly.
   10) Rinse shower room walls and floor prior to exit.
   11) Proceed from shower to changing room and change into street clothes or into new disposable work items.

N. Project Decontamination
1. If the asbestos abatement work is on damaged or friable materials, then the building space is deemed contaminated before start of the work and in need of decontamination. In this case, the procedure includes two cleanings of the primary barrier plastic prior to its removal and two cleanings of the room surfaces to remove any new or existing contamination.
2. Work of this section includes the decontamination of air in the work area which has been, or may have been contaminated by the elevated airborne asbestos fiber levels generated during abatement activities, or which may previously have had elevated fiber levels due to friable materials in the space.
3. Work of this section also includes the cleaning, decontamination, and removal of temporary facilities installed prior to abatement work and decontamination of all surfaces (ceiling, walls, floor) of the work area, and all furniture or equipment in the work area.
4. First Cleaning
   a. Carry out a first cleaning of all surfaces of the work area including items of remaining sheeting, tools, scaffolding and/or staging by use of damp-cleaning and mopping, and/or a HEPA filtered vacuum. (Note: A HEPA vacuum will fail if used with wet material). Do not perform dry dusting or dry sweeping. Use each surface of a cleaning cloth one time only and then dispose as contaminated waste. Continue this cleaning until there is no visible debris from removed materials on plastic sheeting or other surfaces. Upon authorization of the Owner's Representative proceed with encapsulation of substrate.
   b. Perform encapsulation of substrate where required at this time. Maintain pressure differential system in operation during encapsulation work. Allow encapsulant to dry before proceeding with removal of Secondary layer of plastic.
5. Second Cleaning
   a. Upon authorization of the Owner's Representative, remove all Primary Barrier sheeting and Material Decontamination Unit, if there is one, leaving only the following:
      1) Critical Barrier which forms the sole barrier between the work area and other portions of the building or outside.
      2) Critical Barrier Sheeting over lighting fixtures and clocks, ventilation openings, doorways, convectors, speakers and other openings.

3) Personnel Decontamination Unit.
4) Pressure Differential System in continuous operation.

b. Remove all filters in Air Handling System(s) and dispose of as asbestos-containing waste.

6. Final Cleaning: Carry out a final cleaning of all surfaces in the work in the same manner as the first cleaning immediately after removal of primary plastic. This cleaning is now being applied to existing room surfaces. Take care to avoid water marks or other damage to surfaces.
7. Visual Inspection: Perform a complete visual inspection with the Owner's Representative of the entire work area including decontamination unit, all plastic sheeting, seals over ventilation openings, doorways, windows, and other openings; look for debris from any sources, residue on surfaces, dust or other matter. If any such debris, residue, dust or other matter is found repeat cleaning and continue decontamination procedure from that point. When the area is visually clean, complete the certification at the end of this section.
8. Final Air Sampling
   a. After the work area is found to be visually clean, air samples will be taken and analyzed in accordance with the procedures set forth in Paragraph “Powered Air Purifying Respirator (PAPR).
   b. If Release Criteria are not met, repeat cleaning and continue decontamination procedure from that point.
   c. If Release Criteria is met, remove the interior of the decontamination unit leaving in place only the Critical Barriers separating the work area from the rest of the building and the operating negative pressure system.
   d. Any small quantities of residual material found upon removal of the plastic sheeting shall be removed with a HEPA filtered vacuum cleaner and local area protection. If significant quantities, as determined by the Owner's Representative, are found then the entire area affected shall be decontaminated as specified herein for the cleaning.

O. Work Area Clearance
1. Air Monitoring
   a. Visual Inspection is required as a prerequisite of air testing.
   b. To determine if the elevated airborne asbestos structure concentration during abatement operations have been reduced to the specified level, the Owner's Representative will secure samples and analyze them according to the following procedures.
2. Aggressive Sampling
   a. All air samples will be taken using aggressive sampling techniques as follows. (There are no standards available for flow rate of leaf blowers or large fans. However, this information is not critical to the success of the procedure).
   b. Before sampling pumps are started, the exhaust from forced-air equipment (leaf blower with at least 1 horsepower electric motor) will be swept against all walls, ceilings, floors, ledges and other surfaces in the room. This procedure will be continued for five minutes per 10,000 cubic feet of room volume.
   c. Air samples will be collected in areas subject to normal air circulation away from room corners, obstructed locations, and sites near windows, doors or vents.
3. Schedule of Air Samples
   a. General: The number and volume of air samples taken and analytical methods used by the Owner's Representative will be in accordance with the following schedule. Sample volumes given may vary depending upon the analytical instruments used. In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM of TEM analysis.
   b. Transmission Electron Microscopy (TEM) Samples:
      1) In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM or TEM analysis as follows:
      2) Samples will be collected on 25 mm cassettes with filter media: TEM - 0.45 micrometer mixed cellulose ester or 0.40 micrometer polycarbonate, with 5.0 micron mixed cellulose ester backing filter.

Location **Sampled**	Number of **Samples**	Detection **Limit** (f/cc)	**Minimum** Volume (Liters)	**Rate** LPM
Each Work Area	5	0.005	1,300	2-10

3) TEM Analysis will be performed using the analysis method set forth in the AHERA Regulation 40 CFR Part 763 Appendix A.
4) Asbestos Structures referred to in this Section include asbestos fibers, bundles, clusters, or matrices, as defined by method of analysis.
5) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

c. Phase Contrast Microscopy (PCM) Samples:
1) In each homogeneous work area after completion of all cleaning work, samples may be taken and analyzed as follows:
2) Samples will be analyzed by PCM for clearance in areas where ceiling tile and/or pipe insulation are removed
3) Samples will be collected on 25 mm cassettes with filter media: PCM - 0.8 micrometer mixed cellulose ester.

Location Sampled	**Number of Samples**	**Detection Limit** (s/cc)	**Minimum Volume** (Liters)	**Rate** LPM
Each Work Area	1-5	0.01	2,400	2-10

4) PCM Analysis: Fibers on each filter will be measured using the NIOSH 7400 Method entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987.
5) Fibers: Referred to in this section include fibers regardless of composition as counted by the phase contrast microscopy method used
6) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

4. Failure of Clearance Sampling: Should results from analysis of final clearance air samples not meet the specified criteria, Contractor will be responsible for the payment of all costs, including Consultant's time for subsequent clearance air sampling. The costs associated with subsequent re-sampling for final clearance shall be deducted from the Contractor's final payment of the contract amount.

P. Removal Of Pipe Insulation
1. The work of this section applied to the removal of asbestos-containing Pipe Insulation.
a. Place one layer of 6-mil fire retardant polyethylene sheeting directly below the work. The sheet shall be of sufficient size to completely wrap the pipe once it has been removed.
b. Thoroughly wet the ends of the pipe with amended water and scrape off a minimum of 6 inches of asbestos wrap from both ends of the pipe. Immediately place the wetted material into pre-labeled asbestos disposal bag(s).
c. Detach the pipe at each scraped end and place the pipe onto one sheet of 6-mil fire retardant polyethylene sheeting. Wrap the pipe with the 6-mil fire retardant polyethylene sheeting. Contractor shall wrap the pipe with a second sheet of 6-mil, fire retardant polyethylene sheeting and label as asbestos-containing material. Dispose of the bag(s) and duct in accordance with the Paragraph "Handling and Disposal of Asbestos Contaminated Waste" of this specification.
d. Upon clearance from the Owner's Representative, Contractor shall remove the 6-trail, fire retardant polyethylene sheeting from the openings.

Q. Glove Bag Removal

1. The work of this section applies to full containment or glovebag removal.
2. Isolate the area in accordance with Paragraph "Temporary Facilities."
3. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area.
4. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Pressure Differential System."
    a. Upon approval of the enclosure by the Owner's Representative, Contractor may proceed to remove the material using the following method.
    b. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing insulation to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions. If insulation is covered with canvas, Contractor will wet the exterior covering and slice it with utility knife while saturating the material.
    c. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
    d. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
    e. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
    f. Contractor must always clean area of visible asbestos debris prior to end of shift.
5. These procedures shall be followed to remove pipe insulation elbows:
    a. Install critical barriers to isolate the work site. Install 2 or 3 Stage Decontamination Units.
    b. HEPA vacuum the work site.
    c. Provide negative air machine in addition to those required, in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 2-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
    d. Locate intake of duct so that airflow is horizontally and slightly downward into intake. Replace primary filter on negative air machine at an interval of no greater than 30 minutes. Allow no more than one scraping or brushing activity per negative air machine.
    e. Check pipe where the work will be performed. Wrap damaged (broken lagging, hanging, etc.), pipe in 6 mil plastic and "candy-stripe" with duct tape. Place one layer of duct tape around undamaged pipe at each end where the glovebag will be attached.
    f. Place necessary tools into pouch located inside glovebag. This will usually include: bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and pre-wetted cloth.
    g. Place one strip of plastic adhesion tape along the edge of the open top slit of glove bag for reinforcement.
    h. Place the glove bag around section of pipe to be worked on and staple top together through reinforcing tape. Next, tape the ends of glovebag to pipe itself, where previously covered with plastic or tape.
    i. Use smoke tube and aspirator bulb to test seal. Place tube into water sleeve (two-inch opening to glovebag) squeezing bulb and filling bag with visible smoke. Remove smoke tube and twist water sleeve closed. While holding the water sleeve tightly, gently squeeze glovebag and by using a flashlight, look for smoke leaking out, (especially at the top and ends of the glovebag). If leaks are found, tape closed using plastic adhesion tape and re-test.
    j. Insert wand from garden sprayer through water sleeve. Plastic adhesion tape water sleeve tightly around the wand to prevent leakage.

k. One person places its hands into the long-sleeved gloves while the second person directs garden sprayer at the work.
l. Use bone saw, if required, to cut insulation at each end of the section to be removed. A bone saw is a serrated heavy gauge wire with ring-type handles at each end. Throughout this process, spray amended water or removal encapsulant on the cutting area to keep dust to a minimum.
m. Remove insulation using putty knives or other tools. Place pieces in bottom of bag without dropping.
n. Rinse all tools with water inside the bag and place back into pouch.
o. Using scrub brush, rags and water, scrub and wipe down the exposed pipe. (Inexpensive horse rub-down mittens work well for this).
p. Remove water wand from water sleeve and attach the small nozzle from HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag.
q. Remove the vacuum nozzle, twist water sleeve closed and seal with plastic adhesion tape.

R. Handling And Disposal Of Asbestos-Containing Waste
1. All waste and asbestos contaminated waste shall be double bagged in pre-labeled 6-mil airtight puncture resistant bags. Labeling shall be in accordance with OSHA and EPA requirements.
a. Bags of asbestos-containing waste shall be sealed with tape in the work area. Asbestos waste shall not be allowed to dry out prior to sealing bags. While in the work area, bags shall be decontaminated of any bulk debris by wet wiping. Bags shall be pre-labeled in accordance with OSHA and EPA.
b. The Contractor shall ensure that the sealed bags are transported to the waste disposal site.
2. The Contractor shall establish a manifest system to enable the Owner to report the quantity of asbestos waste being deposited at the landfill. Contractor shall report the quantity of waste in pounds or tons as appropriate. The Contractor must be able to demonstrate custody over all asbestos waste from the time it is removed from the work area until it is deposited at the land fill.
a. Copies of the manifest and any receipts generated during the handling and disposal process shall be provided to the Owner's Representative and the Owner.
b. Final manifest and documents must be provided to the Owner's Representative and the Owner within two weeks of the removal of the asbestos materials from the site by the waste hauler.

S. Encapsulation Of Asbestos-Containing Materials
1. General provisions of Contract, including General and Supplementary Conditions and Division 1, apply to work of this section.
a. The work includes the sealing of all piping or vessels from which asbestos-containing insulation has been removed with one coat of a lock down encapsulant.
b. Where repair work is being performed, the end will be sealed with a minimum of one coat of bridging encapsulant.
2. Submittals
a. Product Data: Submit manufacturer's technical information including label analysis and application instructions for each material proposed for use.
b. Installation Instructions: Submit manufacturer's installation instructions with specific project requirements noted.
c. Performance Warrantee: Submit manufacturer's performance guarantee.
d. Certification: Submit written approval of entity installing the encapsulant from encapsulant manufacturer.
e. Safety Data Sheet: Submit the Safety Data Sheet, or equivalent, in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

3. Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
   a. Name or title of material
   b. Manufacturer's stock number and date of manufacture
   c. Manufacturer's name
   d. Thinning Instructions
   e. Application Instructions
4. Deliver materials together with a copy of the OSHA Safety Data Sheet for the material.
5. Job Conditions
   a. Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.
6. Quality Assurance
   a. Installation of Spray-on Encapsulation Materials: Install spray-on materials by a firm and personnel approved by the manufacturer of the primary materials.
   b. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Performance Warranty: Submit written Performance Warranty, executed by the manufacturer and co-signed by the Contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, non-foreseeable ambient exposures or other causes beyond anticipated conditions and manufacturer's/contractor's control.
   d. Compatibility: Selection and use of encapsulant shall be compatible with replacement materials. Submit manufacturer's data indicating compatibility with replacement materials.
7. Product Selection
   a. Encapsulants: Provide penetrating or bridging type encapsulants specifically designed for application to asbestos-containing material.
   b. Standards: Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Fire Safety: Use only materials that have a flame spread index of less than 25, when dry, when tested in accordance with ASTM E84.
8. Manufacturers
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the work, include, but are not limited to the following:
      1) Penetrating Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
      2) Bridging Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
9. General
   a. Prior to applying any encapsulating material, ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
   b. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.
10. Worker Protection
    a. Before beginning work with any material for which a Safety Data Sheet has been submitted, provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

b. In addition to protective breathing equipment required by OSHA requirements or by this specification, use painting pre-filters on respirators to protect the dust filters when organic solvent based encapsulants are used.

11. Substrate
    a. Apply lock down encapsulant to all substrate after all asbestos-containing materials have been removed. Apply in strict accordance with the manufacturer's printed instructions for use of the encapsulation as an asbestos coating. Any deviations from such printed instructions shall be approved by the Owner's Representative in writing prior to commencing work.
    b. Apply encapsulant with an airless spray gun with air pressure and nozzle orifice as recommended by the encapsulant manufacturer.

T. Removal Of Floor Tile
1. This section applies to the removal of floor tile.
    a. Prior to start of work, wet wipe all surfaces including floor tile to remove any visible dust.
    b. Isolate the room by sealing hallway or doors and installing critical barriers on all ducting, windows and other penetrations of the room, in the specified area. Install a splash guard a minimum of 4 feet high on the walls of the room with one layer of 6-mil fire retardant poly.
    c. Install a two-stage decontamination configuration contiguous (under certain conditions may be remote) with the work in accordance with Paragraph “Decontamination Units.”
    d. Using water or amended water in a Hudson-type sprayer or garden sprayer, lightly mist the area where the material is to be removed. This may take several passes with the hose of the sprayer. Allow time for the water to soak into the material.
    e. Immediately place individual tiles in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place the bag into a second prelabeled disposal bag. Tape shut the second bag.

U. Removal Of Fireproofing
1. The work of this section applies to the removal of all asbestos containing fireproofing including all over-spray that may be located on concrete block, columns, metal deck, beams, fixtures conduit and ducting.
    a. Isolate the floor per Paragraph “Temporary Enclosure.”
    b. Construct a decontamination unit as described in Paragraph “Decontamination Units” and attach to the work area.
    c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph “Temporary Pressure Differential and Air Circulation System.”
    d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method.
    e. Pre-clean columns, beams, electrical, mechanical and plumbing systems in the work area using wet wipe and HEPA vacuuming methods. Mask off with flame retardant polyethylene sheeting to protect from contamination during bulk abatement.
    f. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing fireproofing to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions.
    g. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
    h. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into

disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.

i. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.

j. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 12" diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.

k. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on pressure differential machine at an interval of no greater that 30 minutes. Allow no more than one scraping or brushing activity per pressure differential machine.

V. Removal Of Wall Plaster: HEPA vacuum work site.

1. Place two layers of 6-mil flame retardant polyethylene sheeting on the floor adjacent to the wall to be demolished. Pull the wall down in manageable sections onto the polyethylene sheeting. Control dust and fiber release by misting the air and lightly wetting the material with amended water from a Hudson-type sprayer or garden sprayer as it is demolished.
2. Wrap the first layer of polyethylene sheeting around the material and seal with duct tape. Wrap the second layer of polyethylene sheeting around the bundle and seal with duct tape.
3. Label and dispose of the entire bundle.
4. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is unto the work area, oriented in a direction away from the work. Extend a 12-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
5. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on negative air machine at an interval of no greater that 30 minutes.

W. Clean-Up Of Asbestos-Containing Debris On Ceiling Tile Or Solid Ceiling

1. This section applies to the decontamination of the entire plaster ceiling, removal of existing fiberglass on duct work and removal of all batt insulation covering the existing plaster ceiling.
   a. Isolate the floor per Paragraph "Temporary Facilities."
   b. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area. General Contractor will give direction regarding exact location of decontamination unit(s).
   c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Temporary Pressure Differential and Air Circulation System."
   d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method:
2. These procedures shall be followed to for clean up of asbestos-containing debris on existing plaster ceiling:
   a. This work will be performed prior to the removal of fireproofing. The isolation of the work area is considered essential to the pre-cleaning activities for the total area. Isolate the area in accordance with Paragraph “Temporary Facilities.”
   b. Remove asbestos-containing debris and fiberglass batt and duct insulation and decontaminate the area using the following procedures:
      1) Remove all small debris with the HEPA vacuum.
      2) Gently mist all fiberglass insulation, remove from ducts and ceiling and place into pre-labeled hazardous disposal bags and dispose of in accordance with Paragraph “Disposal of Asbestos Containing Waste Material.”
      3) Exposure of ducting will expose all fireproofing overspray, this material may be removed during the removal of fireproofing from decks and beams.

4) Pick up all large visible debris on the ceiling or any horizontal surfaces and place in the bottom of a 6-mil polyethylene disposal bag conforming to the requirements of Paragraph “Disposal of Asbestos-Containing Waste.” Place pieces in the bag without dropping and avoiding unnecessary disturbance and release of material.
5) HEPA vacuum the entire plaster ceiling surface.

c. Upon completion of the decontamination of the area request a visual inspection of the ceiling and other horizontal surfaces. This area will be considered a portion of work area for the duration of the work and will be included in the final encapsulation of the area.

X. Removal Of Adhesive: This section applies to the removal of all asbestos-containing floor tile and adhesive, sheet vinyl flooring, vinyl floor tile, and baseboard adhesive, etc.

1. Ensure that workers are equipped with proper respiratory protection. In addition to the HEPA cartridges, respirators must also be equipped with organic solvent cartridges.
2. Provide HEPA filtered fan units in the vicinity of the work. Arrange so that units exhaust outside the building. Replace primary filters on HEPA filtered fan units at an interval of no greater than 30 minutes.
3. Apply adhesive removal solvent as recommended by manufacturer after removal of floor tile has been completed.
4. Provide tile adhesive (mastic) remover that meets the following criteria:
   a. Flash Point: 122E or greater.
   b. Special Precautions: No heavy smoke generated if ignited.
   c. Health Effects: Limited to mild skin rash or eye irritation.
   d. Respiratory Protection: MSHA - NIOSH approved Organic vapor cartridges in conjunction with standard HEPA filters.
   e. Petroleum Distillates: None.
   f. Odor: Pine, Citrus or none.

Use of diesel fuel in the removal of tile and baseboard adhesive is strictly prohibited.

5. Remove adhesive in small sections from all areas. Do not allow material to dry out. As adhesive is removed, simultaneously pack rags contaminated with adhesive material into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside of bag and move to material decontamination unit.
6. Upon completion of adhesive removal, thoroughly clean bare substrate of all solvent residue.
7. Place adhesive residue in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place bag into second prelabeled disposal bag. Tape shut the second bag.

CERTIFICATE OF WORKER'S ACKNOWLEDGEMENT

PROJECT NAME: _____

PROJECT ADDRESS: _____

CONTRACTOR: _____

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCER IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with the Owner for the above project requires that: You be supplied with the proper respirator and be trained in its use. You be trained in safe work practices and in the use of the equipment found on the job. You receive a medical examination. These things are to have been done at no cost to you. By signing this certification you are assuring the Owner that your employer has met these obligations to you.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators, and informed ofthe type respirator to be used on the above referenced project. I have a copy of the written respiratory protection manual issued by my employers. I have been equipped at no cost with the respirator to be used on the above project.

TRAINING COURSE: I have been trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. The topics covered in the course included the following:

- Physical characteristics of asbestos
- Health hazards associated with asbestos
- Respiratory protection
- Use of protective equipment
- Pressure differential systems
- Work practices including hands-on or on-the-job training
- Personal decontamination procedures
- Air monitoring, personal and area

MEDICAL EXAMINATION: I have had a medical examination within the last 12 months which was paid for by my employer. This examination included: health history, pulmonary function tests and may have included an evaluation of a chest x-ray.

Signature _____ Witness _____

Printed Name _____ Social Security Number _____

CERTIFICATION OF VISUAL INSPECTION

AREA _____

In accordance with Paragraph "Project Decontamination" the Contractor hereby certifies that it has visually inspected the work area (all surfaces including pipes, beams, ledges, walls, ceiling and floor, Decontamination Unit, sheet plastic, etc.) and has found no dust, debris or residue.

By: _____

Signature _____ Date _____

Print Name _____

Print Title _____

OWNER'S REPRESENTATIVE CERTIFICATION

the Owner's Representative hereby certifies that it has accompanied the Contractor on its visual inspection and verifies that this inspection has been thorough and to the best of its knowledge and belief, the Contractor's certification above is a true and honest one.

Signature _____ Date _____

Print Name _____

Print Title _____

RESPIRATORY PROTECTION PROGRAM

Project Name _____

Location _____

Date _____

Based upon airborne asbestos-fiber counts encountered on previous projects of similar type working on materials similar to those found on the above referenced project. The following level of respiratory protection is proposed for the indicated operations to maintain an Airborne Fiber Count (as measured by the NIOSH 7400 Method) below the specified Permissible Exposure Limit (PEL) inside the respirator face piece.

Operation	Anticipated f/cc	Respiratory Protection	Protection Factor	f/cc in Mask
Installing sheet plastic				
Removing trim in contact with asbestos-containing material				
Removal of architectural finish or fireproofing				
Removal of pipe insulation				
Removal of fitting insulation				
Encapsulation of pipe and boiler insulation				
Gross debris removal				
Cleaning "primary" sheet plastic				
Cleaning "critical" barrier				
Removing Decontamination Unit				
Other				

The Contractor certifies that to the best of its knowledge and belief the above represent a true and accurate representation of Airborne Fiber Counts to be expected for the operations indicated, and are based upon airborne fiber data from past projects with similar materials and operations.

Contractor _____

Signature _____ Date _____

Print Name _____ Title _____

END OF SECTION 02 82 33 00

SECTION 02 82 33 00a - REMOVAL OF NONFRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for removal of nonfriable asbestos-containing materials. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions

1. ACM: Asbestos Containing material which is any material containing more than one percent asbestos.
2. Amended Water: Water containing a wetting agent or surfactant with a maximum surface tension of 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.
3. Area Sampling: Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.
4. Asbestos: The term asbestos collectively refers to a naturally occurring mineral known by the following specific names: chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
5. Asbestos control Area: That area where asbestos removal operations are performed. The area shall be isolated by physical boundaries to assist in the prevention of the uncontrolled access by non-qualified persons.
6. Asbestos Fibers: Those fibers having an aspect ratio of at least 3:1 and longer than-5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.
7. Asbestos Permissible Exposure Limit: 0.1 fibers per cubic centimeter of air as an e-hour time weighted average measured in the breathing zone as by defined 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.
8. Background: The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for contaminated areas are measured in similar but asbestos free locations.
9. Contractor: The Contractor is that individual, or entity under contract to the Owner to perform the herein listed work.
10. Contractor/Supervisor (Asbestos abatement): A person who has successfully completed training and is therefore accredited as a Contractor/Supervisor under a State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763.
11. Critical Barrier: The layer of polyethylene sheeting that covers an opening or penetration in a room or area that is to become a negative pressure enclosure.
12. Encapsulation: The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.
13. Encapsulants: Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.
    a. Removal Encapsulant (can be used as a wetting agent)
    b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)
    c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
    d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).

14. Friable Asbestos Material: Any material containing more than one percent asbestos that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.
15. Glovebag Technique: Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.
16. HEPA Filter Equipment: High efficiency particulate air (HEPA) filtered vacuum and/or exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.
17. the Owner: That qualified person employed directly by the Owner to monitor, sample, inspect the work, and advise the Owner.
18. Negative Pressure Enclosure (NPE): That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.
19. Non-friable Asbestos Material: Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, renovation, removal, or mishap.
20. Personal Sampling: Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.
21. Competent Person (CP): A person who has successfully completed training and is therefore accredited under a legitimate State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763 as a Contractor/Supervisor and shall be appropriately licensed according to the Statutes of the State in which the work is to be performed.
22. TEM: Refers to Transmission Electron Microscopy.
23. Time Weighted Average (TWA): The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.
24. Wetting Agent: A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.

C. Requirements
1. Description of Work: The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures shall be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the use of non-friable removal technique(s) which is governed by 40 CFR 763 as indicated. Provide non-friable removal technique(s) as outlined in this specification for the locations indicated.
2. Medical Requirements: Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.
    a. Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."
    b. Medical Records: Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 30 years after termination of employment and make records of the required medical examinations and

exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

c. Medical Certification: Submit written certification for each worker and contractor/supervisor, signed by a licensed physician indicating that the worker and contractor/supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1910.134 as prescribed by law.

3. Training: Train all personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. The Contractor shall document the training by providing a copy of a current training certification to the the Owner for each person assigned to work on this project. Furnish each employee with respirator training and fit testing documentation as required by 29 CFR 1910.134. Provide instruction on the engineering and other hazard control techniques and procedures to be used on this project.
   a. Employee Training: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level in accordance with 40 CFR 763.
4. Permits, Licenses, and Notifications: Notify the local air pollution control district/agency and the the Owner in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M or applicable state and local regulations. Obtain necessary permits or licenses in conjunction with asbestos removal, encapsulation, hauling, and disposal. Post the permit and/or license at the work site, visible from a non-controlled area. Notify the local fire department 3 days prior to removing fire-proofing material from the building including notice that the material contains asbestos.
5. Environment, Safety and Health Compliance: Comply with the applicable requirements of the current issue of 29 CFR 1926.1101, 40 CFR 61-SUBPART A, and 40 CFR 61-SUBPART M or applicable State or local regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable regulations, or referenced documents vary, the most stringent requirement shall apply.
   a. Site Inspection: While performing asbestos engineering control work, the Contractor shall be subject to on-site inspection by the Federal, State, or local regulatory agencies and the Contracting Officer or its designated representative. If the work is found to be in violation of Federal, State, or local regulations or this specification, the Contracting Officer or its representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the. violation shall be at the Contractor's expense.
6. Respiratory Protection Program: Establish and implement a respirator program as required by ANSI 288.2 and 29 CFR 1910.134. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.
   a. Respirator Program Records: Submit records of the respirator program as required by ANSI 288.2 and 29 CFR 1910.134.
7. Contractor/Supervisor (Asbestos Abatement): The Contractor shall be represented on-site by a trained contractor/Supervisor. This person shall be on-site at all times when asbestos work is in progress. The Qualified Person, as defined herein, can be the Contractor/Supervisor.
8. Hazard Communication: Adhere to all parts of 29 CFR 1910.1200 and 29 CFR 1926.59. Provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the site. Review the Asbestos Survey Report(s) provided by the the Owner, if any.
9. Asbestos Hazard Abatement Plan: Submit a detailed plan of the safety precautions such as lockout, tag-out, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan shall be prepared by the Contractor (and reviewed and signed by an asbestos consultant (LAC) licensed according to the Statutes of the State in which the work is to be performed) for review and

recommendation for approval by the the Owner. The plan shall be forwarded to the the Owner for final approval at least 10 days prior to beginning abatement activities. The plan shall include but not be limited to the detailed description of personal protective equipment and work practices to be used including, but not limited to, respiratory protection, type of whole-body protection , the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos encapsulant to be used, locations of local exhaust equipment, planned air sampling strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan shall also include both fire and medical emergency response plans. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work.

10. Testing Laboratory: Submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and/or permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis.
11. Landfill Approval: Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA and State and local regulatory agency(s).
12. Waste Shipment Records/Asbestos Waste Manifest: Submit waste shipment records and/or asbestos manifest records, prepared in accordance with applicable Federal, State, or local regulations, signed and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill, within 3 days after delivery.
13. Negative Exposure Assessment: Submit objective data demonstrating that the method(s) used for the specified non-friable ACM removal does not release airborne concentrations of asbestos fibers exceeding the TWA PEL or excursion limit. This data may be from previous work within the last 12 months or from initial exposure assessments on this project. Data from previous work must have been gathered by the firm employed on this contract, using workers trained to the same level, with the ACM and workplace conditions "closely resembling" the conditions for this contract.
14. Contractor Daily Reports: Prepare a written report for each day that asbestos work is being accomplished. The report should be submitted to the the Owner monthly. The report as a minimum shall include the following, where applicable:
    a. Daily Visual Inspection Reports: Prepare a written report documenting compliance with the Asbestos Hazard Abatement Plan and Federal, State, or local regulations.
    b. Air Sampling Reports: Complete fiber counting within 24 hours of the "time off" of the sample pump. Notify the the Owner immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Sampling results shall be submitted to the the Owner the day following receipt. The affected employees will be provided copies of the results where required by law within 3 working days. These results shall be signed by the air sampler and the testing laboratory employee that analyzed the sample.
    c. Pressure Differential Recordings for Local Exhaust System-Not Used
    d. Asbestos Disposal Quantity Report: The Contractor shall record and report daily the amount of asbestos containing material removed and the amount transported for disposal. Deliver the report for the previous day and cumulative totals with amounts of material removed reported in linear meters or square meters linear feet or square feet as described initially in this specification and the amounts of material transported for disposal reported in cubic meters yards.

D. Submittals
1. Submit the following in accordance with Section "Submittal Procedures."
a. Vacuums and tools
b. Respirators
c. Wetting Agent
d. Safety Data Sheets (SDS) for all materials proposed for transport to the project site
e. Local exhaust system
f. Pressure differential automatic recording instrument
g. Daily Reports
h. Asbestos hazard abatement plan
i. Testing laboratory
j. Training Certificates
k. Landfill approval
l. Employee training
m. Medical certification requirements
n. Waste shipment records/Asbestos waste manifest
o. Respiratory Protection Program
p. Negative Exposure Assessment
q. Local Exhaust system
r. Show compliance with ANSI Z9.2 by providing manufacturers' certifications.
s. Permits, licenses, and Notifications
t. Rental equipment
u. Respirator program records
v. Protective clothing decontamination quality control records
w. Protective clothing decontamination facility notification.

E. Quality Assurance
1. Glovebags-Not Used
2. Rental Equipment: Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.
3. Protective Clothing Decontamination Quality Control Records: Provide all records that document quality control for the decontamination of reusable outer protective clothing.
4. Protective Clothing Decontamination Facility Notification: Submit written evidence that persons who decontaminate, store, or transport asbestos contaminated clothing used in the performance of this contract were duly notified in accordance with 29 CFR 1926.1101.

1.2 PRODUCTS

A. Encapsulants
1. See Division 21 Section “Facility Fire-Suppression Water-Service Piping".

1.3 EXECUTION

A. Equipment
1. Respirators: Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH). Provide personnel engaged in pre-cleaning, cleanup, handling, and removal of asbestos containing materials with the appropriate respiratory protection as specified in 29 CFR 1910.134.
2. Exterior Whole Body Protection
a. Outer Protective Clothing: Provide personnel exposed to asbestos with disposable "non-breathable," or reusable "non-breathable" whole body outer protective clothing, head

coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape. Reusable whole body outer protective clothing shall be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly decontaminated.

b. Work Clothing-Not Used

c. Decontamination of Reusable Outer Protective Clothing: When reusable outer protective clothing is used, transport the double bagged clothing to a previously notified commercial/industrial decontamination facility for decontamination. Perform non-destructive testing to determine the effectiveness of asbestos decontamination. If representative sampling is used, ensure the statistical validity of the sampling results. If representative sampling is used, reject any entire batch in which any of the pieces exceed 40 fibers per square millimeter. Inspect reusable protective clothing prior to use to ensure that it will provide adequate protection and is not or is not about to become ripped, torn, deteriorated, or damaged, and that it is not visibly contaminated. Notify, in writing, all personnel involved in the decontamination of reusable outer protective clothing as indicated in 29 CFR 1926.1101.

d. Eye Protection: Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

3. Warning Signs and Labels: Provide bilingual warning signs printed in English and Spanish at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.

a. Warning Sign: Provide vertical format conforming to 29 CFR 1926.1101 minimum 20 by 14 inches (500 by 355 mm) displaying the following legend in the lower panel:

DANGER
ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY
WEAR RESPIRATORY PROTECTION AND
PROTECTIVE CLOTHING IN THIS AREA

b. Warning Labels: Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

c. Provide the following asbestos labels, of sufficient size to be clearly legible, for display on waste containers (bags or drums) which will be used to transport asbestos contaminated material in accordance with United States Department of Transportation 49 CFR Parts 171 and 172.

NA2212, (WASTE) ASBESTOS, 9, PGIII

4. Vacuums and Tools: Vacuums shall be leak proof to the filter and equipped with HEPA filters. Filters on vacuums shall conform to ANSI Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse.

B. General
1. Pre-Asbestos Work Conference: The Contractor and the Contractor/Supervisor shall meet with the Contracting officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Owners Engineer, the plan will be enforced as if a part of this specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan to allow for free discussion and approval by the Owners Engineer prior to starting work.
2. Asbestos Control Area Requirements: The Contractor shall demarcate the asbestos control area(s) using physical barriers and signs to prevent access by unauthorized personnel. This area is defined by 29 CFR 1926.1101 as the regulated area.
3. Work Procedure: Perform asbestos related work in accordance with 29 CFR 1926.1101, 40 CFR 61-SUBPART M, applicable State or local regulation, and as specified herein. Use wet removal procedures. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, drinking, chewing gum or tobacco, or applying cosmetics shall not be permitted in the asbestos control area(s). Personnel of other trades not engaged in the removal of asbestos containing material shall not be exposed at any time to airborne concentrations of asbestos. If an asbestos fiber release or spill, stop work immediately, correct the condition to the satisfaction of the Owners Engineer, including clean-up and clearance sampling, if appropriate, prior to resumption of work.
4. Furnishings: Furniture will be removed from the area of work by the Owner before asbestos work begins.
5. Pre-cleaning: Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.

C. Removal Procedures: Wet asbestos containing material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 0.15 mm 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 0.15 mm 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Owner's Engineer for approval. Asbestos containing material shall be containerized while wet. At no time shall asbestos containing material be allowed to accumulate or become dry. Handle asbestos containing material as indicated in 40 CFR 61-SUBPART M, applicable State or local regulation, and 29 CFR 1926.1101.
1. Exposed Pipe Insulation Edges-Not Used
2. Negative Pressure Enclosure: Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area.
   a. Personnel/Equipment Decontamination Unit: Provide a temporary facility with a separate equipment/dirty change room and clean change room. Provide a shower that complies with 29 CFR 1926.51 in between the dirty room and clean room for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. All

employees shall shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste or properly decontaminate as specified in the Asbestos Hazard Abatement Plan.

b. Waste Load-Out Unit: Provide a separate temporary area expressly for short-term storage of bagged asbestos containing material that is ready for disposal. The unit shall be the only port used to transfer waste to a truck, dumpster, or other approved on-site storage facility. It shall not be used for personnel egress. A waste load-out unit shall be integral to each negative pressure enclosure.

3. Non-friable Removal Procedures:
   a. Under normal conditions EPA Category II, non-friable asbestos containing materials may not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal; therefore it must be handled in a manner to prevent the release of asbestos fibers. At no time will this material be mechanically chipped, sawed, sanded, or ground.
   b. Prior to beginning removal, establish an Asbestos Control Area and install Critical Barriers as specified elsewhere in this section. Submit a Negative Exposure Assessment which is less than 12 months old to the the Owner for approval or conduct air sampling as specified elsewhere in this section to establish the exposure levels for the exact removal method being used. The Contractor will establish the correct level of Personal Protective Equipment required.
   c. Acceptable methods of removal include, but are not limited to, the use of dry ice, a heat gun or lamp, citrus-based solvents, and hand tools with amended water. Removal shall be accomplished to keep the ACM substantially intact. Breakage into small pieces is an unacceptable work practice. The method shall-be detailed in the Asbestos Abatement Plan and shall not be changed during the removal without Contracting Officer approval.
   d. Upon completion of the removal and clean-up, but prior to removal of critical barriers, the Contractor Testing company shall conduct a visual inspection of all areas affected by the removal. Re-clean as required.

D. Field Quality Control Requirements
1. Visual Inspections: The the Owner will conduct periodic inspections of all areas where asbestos removal and activities are in progress to ensure compliance with the approved Asbestos Hazard Abatement Plan and Federal/State regulatory requirements. This inspection shall include confirmation of proper control/containment/enclosure, worker protection, housekeeping, exhaust equipment operation, decontamination procedures, proper wetting and disposal, and inspection of work progress and work practices. Each activity will be documented as acceptable or noted as unacceptable with justification for the non-compliance.
2. Air Sampling: Sampling of airborne concentrations of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101 and as specified herein. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Air Sampling may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate.
   a. Sampling Prior to Asbestos Work (Not Used)
   b. Sampling During Asbestos Work
      1) The Contractor's testing company shall perform area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Perform area sampling at least once every week close to the work inside the enclosure, outside the personnel/equipment decontamination unit entrance to the enclosure.
      2) If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the fiber release, and notify the the Owner immediately.

Determine by testing if adjacent areas are contaminated. If so the Contractor shall clean the contaminated areas, visually inspect, and sample the areas as specified herein.

3) The Contractor shall conduct personal sampling of at least 25% of the workers engaged in asbestos handling (removal, disposal, transport and other associated work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers at any time exceeds 0.1 fibers per cubic centimeter, notify the PQP immediately, evaluate work practices, and take corrective action to reduce airborne asbestos fibers.

E. Clean-Up And Disposal

1. Housekeeping
   a. Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. All asbestos waste shall be placed in an approved on-site storage facility or transported for disposal daily. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the PQP shall visually inspect the asbestos control area for cleanliness. After final clean-up and acceptable pre-clearance airborne concentrations are attained but before the local exhaust system is turned off and the negative pressure enclosure removed), remove all pre-filters on the building HVAC system and provide new pre-filters.
   b. Dispose of filters as asbestos contaminated materials. Reestablish HVAC,. mechanical, and electrical systems in proper working order.
2. Title to Materials: All waste materials, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified in applicable Federal, State, and local regulations and herein.
3. Disposal of Asbestos
   a. Collect all removed asbestos containing material, contaminated materials, contaminated water, scrap, debris, bags, containers, expendable equipment, and asbestos contaminated clothing which may produce airborne asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 0.15 mm 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 0.15 mm 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag.
   b. Each container or bag shall clearly indicate that the waste generator is the Owner and the development at which the waste is generated, and the Job Order number of the project.
   c. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off the Owner’s property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be coordinated with the the Owner. Procedure for hauling and disposal shall comply with 40 CFR 61-SUBPART M, State, regional, and local standards. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

END OF SECTION 02 82 33 00a

Task	Specification	Specification Description
02 82 33 00	01 11 19 00	No Specification Required
02 82 33 00	02 82 16 00	Engineering Control of Asbestos Containing Materials

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SECTION 02 83 00 00 - LEAD REMEDIATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for lead paint related abatement procedures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. General Provisions

1. The site of this work will be occupied while work is being done. Perform the abatement work with the least inconvenience to the residents.
2. Take all necessary precautions to protect the property of the the Owner and its residents. Damaged property shall be repaired and restored to its original condition. If the damage is beyond repair, the Contractor shall replace it with new materials to match existing, at the Contractor's expense.
3. Hazardous waste generated during the abatement process (including lead-base paint) when carted away from the developments shall not be transferred from one vehicle to another except at a licensed transfer station.
4. Develop a work plan to be performed as requested by the the Owner. The detailed plan shall include sequencing of abatement work in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
5. The Contractor shall include all supplementary miscellaneous items not specified but implied or required in order to complete the work.
6. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.
7. Make in a timely fashion all applicable and necessary notifications to relevant Federal, State and Local authorities. The Contractor shall indemnify the the Owner and the the Owner's representative from, and pay all claims resulting from failure to adhere to these provisions.
8. the Owner may retain an independent Monitoring Contractor to monitor the abatement contract and conduct all wipe sampling and clearance tests.
9. Contractor performing lead-based paint abatement or renovation activities involving lead-based paint shall be a Certified Lead Abatement Contractor and shall ensure that supervisors and workers are trained and certified by U.S. EPA approved state program or equivalent, to perform lead paint removal operations.
10. Establish and implement a Chemical Hazard Communication Program as required by OSHA regulations 29 CFR 1926.59.
11. Provide workers with a comprehensive medical examination as required by OSHA regulations 29 CFR 1926.62 before exposure to lead contaminated dust. The medical examination shall be conducted to approve use of appropriate respirators and shall include biological monitoring NIOSH/MSHA approved respirators shall be utilized.
12. For employees required to wear a negative pressure respirators: conduct a respirator fit test at the time of initial fitting and at least once every six (6) months thereafter as required by OSHA regulations 29 CFR 1926.62.
13. Determine if any worker will be exposed to lead at or above the action level in accordance with OSHA regulation 29 CFR 1926.62 and 29 CFR 1910.1025. Conduct an exposure assessment to identify the level of exposure a worker would be subjected to without respiratory protection. Assess the exposure level by obtaining personal monitoring samples representative of a full shift of at least an 8-hour TWA.
14. Furnish appropriate respirators approved by NIOSH/MSHA for use in atmospheres containing lead aerosols. Instruct workers in all aspects of respiratory protection. Maintain an adequate supply of HEPA filter elements and spare parts on site for all types of respirators in use.

15. For manual demolition, scraping, sanding, use of heat gun or power tool paint removal with HEPA collection systems, workers shall minimally use the half-mask negative pressure respirator with high efficiency filters (for airborne concentrations not in excess of 500µg/m³).
16. Ensure that work area preparation, work practices, and clean-up procedures comply with these specifications and applicable Federal, State and Local regulations.
17. Notify all applicable agencies five days prior to the date the abatement will begin and provide evidence of notifications to the the Owner at the pre-start meeting.

C. Submissions
1. Within ten (10) consecutive calendar days calculated from the date of the the Owner's Job Order, the Contractor shall tender all required submissions. Six (6) sets of each submission are required. Where physical samples are required two (2) physical samples shall be submitted for each item. In general, items shall include but not be restricted to the following:
   a. Paint remover - corner cutter/Vac-Pac System by Pentek Inc; Decontamination Products Division 1026 Fourth Avenue, Corapolis, PA. 15108. Telephone No. (412) 262-0725 or approved equal.
   b. Description of removal method to be used on each substrate condition including manufacturer's operating instructions and recommendation for equipment usage.
   c. Copies of current training certificates of Staff to be assigned to the contract.
   d. List of three previous lead abatement jobs performed successfully by Contractor and name, address, and telephone number of contact person for verification.
2. In the event that all or any portion of the submitted material is rejected by the the Owner, the Contractor shall tender new submissions. All submissions returned for corrections shall be resubmitted with the required corrections within ten(10) consecutive calendar days calculated from the date of rejection, until final submissions are obtained that require no further correction. In no event shall the Contractor be permitted to tender submissions hereunder beyond twenty (20) days from the the Owner's Job Order, unless duly extended in writing by the the Owner.
3. No work shall begin, nor shall the materials be ordered or delivered to the site until final approval of all submissions.

D. Applicable Regulations
1. 24 CFR Part 35
2. HUD ”Guidelines For the Evaluation and Control of Lead-Based Paint Hazards in Housing”
3. Abatement work shall also be in accordance with applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any State or Local LBP standards. Where there is a conflict between Federal, State or Local regulations, the more stringent requirement shall prevail.
4. OSHA Standards
   a. 29 CFR 1926.20 General safety and health provisions;
   b. 29 CFR 1926.21 Safety training and education;
   c. 29 CFR 1925.25 Housekeeping;
   d. 29 CFR 1926-28 Personal protective equipment;
   e. 29 CFR 1926.51(f) Washing facilities;
   f. 29 CFR 1926.55 Gases, vapors, fumes, dusts, and mists;
   g. 29 CFR 1926.57 Ventilation
   h. 29 CFR 1926.59 Hazardous Communication Standards;
   i. 29 CFR 1926.103 Respiratory protection, and
   j. 29 CFR 1926.62 Lead in Construction
5. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).
6. These Specifications refer to many requirements found in the preceding references but in no way is it intended to cite or reiterate all provisions therein or elsewhere. It is the Contractor's responsibility to obtain a copy, and know, understand and abide by all such regulations, guidelines and common practices.

1.2 PRODUCTS – (not used)

1.3 EXECUTION

A. Abatement
1. Have risk assessment or paint inspection performed by certified risk assessor or a certified inspector technician who is independent of the abatement contractor.
2. Develop a site specific lead hazard control plan, reviewed and signed by an asbestos consultant (LAC) who is licensed in the State in which the work is to be performed, and submit for review and approval to the the Owner.
3. Obtain any necessary building or waste permits, notify local authorities as required by applicable codes and laws.
4. Select specific building component replacement items, enclosure materials, paint removal equipment and/or chemicals, tools, and cleaning supplies. Consider waste management and historical preservation implications of selected treatment.
5. Develop project specific specifications.
6. Schedule other work so that leaded surfaces are not inadvertently disturbed and unprotected workers are not place at risk. Include time for clearance examinations and laboratory dust sample analysis in the scheduling process.
7. Select a certified abatement subcontractor.
8. Conduct a pre-construction conference to ensure that the subcontractor fully understands the work involved.
9. Notify residents of the dwelling and adjacent dwellings of the work and date it will begin. Coordinate this with the the Owner.
10. Correct any existing conditions that could impede the abatement work (i.e. trash removal, structural deficiencies).
11. Post warning signs and restrict entry to work area to authorized personnel. Implement worksite preparation procedures.
    a. Place proper warning signs required by OSHA regulations at all entrances to the work area. Signage shall be minimum of 12" x 20" and shall state the following:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

12. Coordinate test, pilot or sample portion approach to the project with the Owner.
13. Shut-down forced air heating, ventilation and air conditioning systems and cover all vents, diffusers, windows etc., with a single layer six-mil polyethylene sheet secured with duct tape. Exceptions shall be for minor disturbances of area less than 2 square feet and where if vents, diffusers, and windows are more than 5 feet away from surface being disturbed, they need not be covered.
14. Collect preabatement soil samples, which may not have to be analyzed until post abatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed.
15. Cover entrances to the work area with a single layer of 6 mil polyethylene sheets taped to the top and weighted at bottom.
16. Rig a containment non-flammable polyethylene sheet underneath the work area. This containment method should catch all stripped paint for proper disposal.
17. Execute abatement work.
18. Avoid spreading dust and debris outside the work area.
19. Store all waste in a secure area and make sure it is properly labeled with an accumulation start date.
20. Conduct daily and final cleanup.
21. Execute waste disposal procedures.

22. Maintain appropriate records.

B. Paint Removal
1. Do not use the following prohibited paint removal methods:
   a. Dry scraping or sanding (except for limited areas)
   b. Use of heat gun over 1,100°F
   c. Open flame burning or torching
   d. Machine sanding or grinding without HEPA vacuum exhaust tool
   e. Abrasive blasting or sandblasting without HEPA vacuum exhaust tool
   f. Uncontained hydro blasting or high-pressure wash
   g. Use of chemical strippers containing Methylene chloride.
2. Select the appropriate worksite preparation level.
3. For heat gun work, provide fire extinguishers in the work area and ensure that adequate electrical power is available. Use for limited areas only. Train workers to avoid gouging or abrading the substrate.
4. For mechanical removal methods, use tools equipped with HEPA exhaust capability. Be sure workers keep the shroud against the surface being treated. Vacuum blasting and needle guns should not be used on wood, plaster, drywall, or other soft substrates. Observe all manufacturers directions for the amount of vacuum airflow required.
5. For wet scraping, use a spray bottle or wet sponge attached to the scraper to keep the surface wet while scraping. Apply enough water to moisten the surface completely, but not so much that large amounts of water run onto the ground or floor. Do not moisten areas near electrical circuits.
6. For chemical paint removers, determine if the building component can be removed and stripped offsite. Offsite stripping is generally preferred to onsite paint removal. Observe all manufacturers' directions for use of paint removers.
7. For offsite stripping, determine how to remove the component. Score the edges with a knife or razor blade to minimize the damage to adjacent surfaces. Punch or tag the building component, if similar building components are also being stripped offsite (i.e. doors). This will ensure that the individual component is reinstalled in the same location. Inform the offsite paint remover that the lead-based paint component is present for shipping. Wrap the component in plastic and send to the offsite stripping location. Clean all surfaces before reinstallation and remove any lead residue by HEPA vacuuming all surfaces, cleaning with other lead-specific cleaners, or phosphate detergents, and HEPA vacuuming again.
8. For onsite paint removal, first test the product on a small area to determine its effectiveness. Chemical paint removers may not be effective or desirable on exterior, deteriorated wood surfaces, aluminum, and glass. Provide neoprene, nitrile, rubber, or polyvinyl chloride (PVC) gloves (or other type of glove recommended by the manufacture); face shields; respirators with combination filter cartridges for lead dust and organic vapors(if appropriate); and chemically resistant clothing. Be sure to select the right type of organic vapor filter cartridge, gloves, and clothing for the specific chemical being used. Portable eyewash stations capable of providing a 15-minute flow must be on-site. Apply the chemical and wait the required period of time. Securely store chemical s overnight. For caustic chemical paint removers, neutralize the surface before repainting using glacial acetic acid (not vinegar). Repaint.
9. Make sure all debris is caught in the containment sheet for proper disposal.
10. Mark and legally dispose of waste in accordance with all applicable Federal, State and Local regulations. Most wastes from paint removal projects, such as paint chips and paint remover sludge, will need to be managed as hazardous waste.
11. Conduct clean-up
12. Have a certified risk assessor or inspector technician conduct a clearance examination and provide documentation and a Statement of Lead-Based Paint Compliance.

C. Building Component Replacement
1. Prepare work area by selecting proper worksite preparation level.
2. Prepare the hazardous material building component for removal. Turn off and disconnect any electrical circuits inside or near the building component to be removed.

3. Lightly mist the component to be removed (unless electrical circuits are located nearby).
4. Score all painted seams with a sharp knife.
5. Remove any screw, nails, or other fasteners.
6. Use flat pry instrument and hammer to pry component from the substrate.
7. Remove or bend back all nails.
8. Wrap and seal all bulk components in plastic and take them to a covered truck or secured waste storage area along a pathway covered in plastic. Shovel any debris. Dispose of properly.
9. HEPA vacuum any dust or chips in the area where the component was located.
10. Conduct cleaning and clearance activities.

D. Soil and Exterior Dust Abatement
1. Determine if soil lead hazard exists. For hazard to exist, a total of at least 9 square feet of soil in a single yard or area must be bare and soil concentrations must exceed 2,000µg/gram lead for the yard or building perimeter or 400µg/gram of lead for small, high-contact play areas (pending the development of an EPA soil standard). Bare soil above these levels shall be treated by either interim controls or abatement. Soil abatement is most appropriate when levels of lead are extraordinarily high (greater than 5,000µg/gram lead) and when use patterns indicate contact frequency and exposure will be high.
2. Collect Preabatement soil samples to determine baseline levels. These samples need not be analyzed if post abatement samples are below applicable clearance levels.
3. Determine the method of soil abatement (soil removal and replacement, soil cleaning, or paving). Soil cultivation (rototilling or turning over the soil) is not permitted.
4. If paving, use a high quality concrete or asphalt. Observe normal precautions associate with traffic load weight and thermal expansion and contraction. Obtain necessary permits. Keep soil cultivation to a minimum.
5. If removing and replacing soil.
    a. Determine if waste soil will be placed in an offsite burial pit. Prepare vehicle operation and soil movement plan. Test new replacement soil (should not contain more than 200 µg/gram lead).
    b. Contact local utilities to determine location of underground utilities including water, gas, cable TV, electric, telephone, and sewer. Mark all locations to be avoided
    c. Remove fencing, if necessary to allow equipment access and define set limits with temporary fencing, signs, or yellow caution tape.
    d. Tie and protect existing trees, shrubs, and bushes.
    e. Have enough tools to avoid handling clean soil with contaminated tools.
    f. Remove soil.
    g. Clean all walkways, driveways, and street areas near abatement area.
    h. Replace soil at proper grade to allow drainage. Replacement soil should be at least 2 inches above existing grade to allow for settling.
    i. Install new soil covering (grass or sod) and maintain it through the growing season.
    j. Determine if soil waste is hazardous and manage it accordingly
    k. Conduct clean-up and clearance.
    l. Provide walk-off doormats.
    m. Maintain proper documentation.

E. Encapsulation
1. Determine if the applicable regulations aloe encapsulates to be used. Do not encapsulate the following surfaces:
    a. Friction surfaces, such as window jambs and door jambs.
    b. Surfaces that fail patch tests.
    c. Surfaces with substrates or existing coatings that have a high level of deterioration.
    d. Surfaces I which there is a known incompatibility between two existing paint layers.
    e. Surfaces that cannot support the additional weight stress of encapsulation due to existing paint thickness.
    f. Metal surfaces that are prone to rust or corrosion.
2. Conduct field tests of surfaces to be encapsulated for paint film integrity.

3. Consider special use and environmental requirements (i.e. abrasion resistance and ability to span base substrate cracks).
4. Provide to the the Owner encapsulant test data provided by the manufacturer.
5. Conduct at least one test patch on each type of building component where the encapsulant will be used. Report the results to the the Owner.
6. For both nonreinforced and reinforced coatings, use a 6" x 6" test patch area. Prepare the surface in the manner selected to complete the job. Prepared surfaces for patch testing should be at least 2" larger in each direction than the patch area.
7. For fiber-reinforced wall coverings, use 3" x 3" patch. For rigid coatings that cannot be cut with a knife, use soundness test. For all encapsulants, carry out the appropriate adhesion tests.
8. For liquid coating encapsulants, allow coating to cure, then visually examine it for wrinkling, blistering, cracking, bubbling, or other chemical reaction with the underlying paint.
9. Record results of all patch tests and provide to the the Owner.
10. Implement proper work site preparation level.
11. Repair all building components and substrates as needed (i.e. caulk cracks and repair sources of water leaks).
12. Prepare surfaces. Remove all dirt, grease, chalking paint, mildew and other surface contaminants, remnants of cleaning solutions, and loose paint. All surfaces should be deglossed, as needed.
13. Ventilate the contaminated area whenever solvents or chemicals are used.
14. During encapsulant application or installation, monitor temperature and humidity. For liquid coatings monitor coating thickness to ensure that the encapsulant manufacturer's installation/application specifications are followed.
15. Conduct clean up and clearance.
16. Provide the the Owner information on how to care for the encapsulation system properly.
17. Maintain records on the exact detailed locations of encapsulant applications, patch test specifications and results, product name, subcontractor, date of application, a copy of the product label and Safety Data Sheet (SDS) for the product and provide to the the Owner.

F. Enclosure
1. Stamp, label or stencil all lead-based painted surfaces that will be enclosed with a warning approximately every 2 feet both horizontally and vertically on all components. The Warning shall read "**Danger Lead-Based Paint**". Deteriorated paint should not be removed from the surface to be enclosed.
2. Select the proper worksite preparation level.
3. Attach a durable drawing to the utility room closet showing where lead-based paint has been enclosed in the dwelling.
4. An independent inspector or technician or risk assessor should evaluate the integrity of the enclosure.
5. Repair any unsound substrates and structural members that will support the enclosure, if necessary.
6. Utilize appropriate enclosure material (drywall or fiberboard, wood paneling, laminated products, ridged tile and brick veneers, vinyl, aluminum m, or plywood).
7. Install extension rings for all electrical switches and outlets that will penetrate the enclosure.
8. If enclosing floors, remove all dirt with a HEPA vacuum to avoid small lumps in the new flooring.
9. Seal and back-caulk all seams and joints. Back-caulk means applying caulk to the underside of the enclosure.
10. When installing enclosure directly to painted surfaces, use adhesive and then anchor with mechanical fasteners (screws or nails).
11. Conduct clean up and clearance activities.
12. Maintain proper records and submit a Statement of Lead-Based Paint Compliance.

G. Final Cleaning Procedures
1. Use the following step-by-step procedures

a. Assign responsibilities to specific workers for cleaning and for maintaining the cleaning equipment.
b. Have sufficient cleaning equipment and supplies before beginning work.
c. If contamination is extensive, conduct precleaning of the dwelling unit.
d. Conduct ongoing cleaning during the job, including regular removal of large and small debris and dust. Decontamination of all tools, equipment and worker protection gear is required before it leaves contaminated areas. Electrical equipment should be wiped and high-efficiency particulate air (HEPA) vacuumed, not wetted down, to minimize electrocution hazards.
e. Schedule sufficient time (usually 30 minutes to an hour) for complete daily cleaning, starting at the same time near the end of every workday after lead hazard control activity has stopped.
f. For final cleaning, wait at least 1 hour after active lead hazard control activity has ceased to let dust particles settle.
g. Use a vacuum cleaner equipped with a HEPA exhaust filter. HEPA vacuum all surfaces in the room (ceilings, walls, trim, and floors). Start with the ceiling and work down, moving toward the entry door. Completely clean each room before moving on.
h. Wash all surfaces with lead-specific detergent, high-phosphate detergent, or other suitable cleaning agent to dislodge any ground-in contamination, then rinse. Change the cleaning solution after every room is cleaned.
i. Repeat step g above. To meet clearance standards consistently, a HEPA vacuum, wet wash, and HEPA vacuum cycle is recommended. For interim control projects involving dust removal only, the final HEPA vacuuming step is usually not needed. Other cleaning methods are acceptable, as long as clearance criteria are met and workers are not over exposed.
j. After final cleaning perform visual examination to ensure that all surfaces requiring lead hazard control have been addressed and all visible dust and debris have been removed. Record findings and correct any incomplete work.
k. If other construction work will disturb the lead-based paint surfaces, it should be completed at this point. If those surfaces are disturbed, repeat the final cleaning step after construction work has been completed.
l. Paint and otherwise seal treated surfaces and interior floors.
m. Conduct clearance examination.
n. If clearance is not achieved, repeat final cleaning.
o. Continue clearance testing and repeated cleanings until dwelling unit achieves compliance with all clearance standards. The cost of repeated cleaning, after failure to achieve clearance is to be borne by the contractor.
p. Do not allow residents to enter work area until final cleaning is completed and clearance is established.
q. Cleaning equipment list is as follows:
    1) HEPA Vacuums
    2) Detergent
    3) Waterproof gloves
    4) Rags
    5) Sponges
    6) Mops
    7) Buckets
    8) HEPA vacuum attachments (crevice tools, beater bar for cleaning rugs)
    9) 6-mil plastic bags
    10) Debris containers
    11) Waste water containers
    12) Shovels
    13) Rakes
    14) Water-misting sprayers
    15) 6-mil polyethylene sheeting (or equivalent)

2. Order of execution for final cleaning steps should be as follows:

a. As the first stage in final cleaning, floor plastic shall be misted and swept.
b. Upper level plastic, such as on cabinets and counters should be removed first, after it has been misted and cleaned. All plastic should be carefully folded from the corners/ends to the middle to trap any remaining dust. Next remove both layers of plastic from the floor.
c. Plastic sheets used to isolate contaminated rooms from noncontaminated rooms should remain in place until after cleaning and removal of other plastic sheeting, these sheets may then be misted, cleaned and removed last.
d. Removed plastic should be placed into double 4-mil or single 6-mil plastic bags, or plastic bags with equivalent (or better) performance characteristics, which are sealed and removed from the premises. As with daily cleanings, this plastic removal process usually requires workers to use protective clothing and respirators.
e. After plastic has been removed from the contaminated area, the entire area should be cleaned using the HEPA/wet wash/HEPA cycle.

H. Waste Testing And Disposal

1. General: All materials, whether hazardous or non-hazardous shall be properly disposed of. the Owner may hire an independent Monitoring Consultant to perform TCLP test to determine which of the wastes are hazardous. Contractor shall cooperate in this test. If less than 100kg (200 lbs) or 1/2 of a 55 gallon drum of hazardous waste per month will be generated, it is considered "conditionally exempt" abatement waste, and may be managed as solid non-hazardous waste. The RCRA hazardous waste manifest is not required when shipping this waste to an offsite disposal facility.
2. Separate Abatement Waste into The Following Four Categories:
   a. Category I. Low lead waste (typically non-hazardous) e.g. Filtered personal and commercial wash water.
   b. Category II. Architectural components - (painted finish carpentry items) e.g. Doors, windows, window trim and sills, baseboards, railings, moldings. (May do a TCLP to determine if they are hazardous).
   c. Category III. Concentrated lead waste e.g. sludge from stripping, lead-base paint chip and dust, HEPA vacuum debris and filter, unfiltered wash waste, any waste included in EPA's list of hazardous waste.
   d. Category IV. Material that cannot be determined to be either hazardous or non-hazardous must be tested by TCLP.

   If the hazardous waste generated is greater than 100kg per month, dispose according to the referenced guidelines and RCRA hazardous waste management requirements including those listed below.
3. Disposal Requirements: Contact the regional EPA, state, local and all other pertinent authorities to determine lead-based paint debris disposal requirements. Comply with requirements of the Resource Conservation and Recovery Act (RCRA) and with applicable federal, state, county, or local waste requirements.
4. EPA ID Numbers: Obtain a Generator RCRA Hazardous Material ID number and coordinate this action through the State and secure any additional number as required.
5. Storage Requirements: Keep all hazardous items in a secure area or lockable container that is inaccessible to all persons other than the Contractor's personnel. Label all hazardous waste "Hazardous Waste" with the date that the Contractor began to collect the waste in that container. Keep hazardous and non-hazardous waste in separate containers. Until TCLP testing is completed, considered all items hazardous and store in a secured area or lockable container.
6. Waste Transportation: Transport hazardous waste using a RCRA/DOT/EPA certified Hazardous Waste Transporter. Submit names and qualifications of certified transporter/hauler for the Owner approval. The Contractor shall be responsible for all actions of the waste hauler as pertaining to waste removal and disposal under these procedures and all EPA, DOT and other applicable regulations.
7. Disposal Facility: Supply documents that detail the site(s) to be used for ultimate disposal. Submit documents from these sites proving that they are licensed/permitted to accept such waste and shall accept the waste proposed by the Contractor for treatment or ultimate disposal.

8. Waste Containers: Comply with EPA and DOT regulations for waste containers. Contact the state and local authorities to determine their criteria for containers. In the case of any conflict in regulations, the more stringent shall apply.
9. Emergencies: Contact local fire, police, hospitals or local emergency response teams and inform them of the type of hazardous waste activity and ask for assistance in the event of any accident. Additionally, the container shall provide the following:
    a. Keep and properly maintain a suitable fire extinguisher(s) on site.
    b. Have a immediate means of communication with the regulatory agency in the event of an emergency.
    c. Keep a list of phone numbers of regulatory agencies on site.
    d. Appoint an emergency coordinator and ensure the coordinator is on site to supervise emergency procedures to be carried out in the event of an emergency.
    e. Keep and maintain a "right to know" manual that is in an easily accessible location and in an area that is known to all employees.
10. Transporting Waste: Provide certifications that the transporter is registered with the U.S. Department of Transportation is required by 49 CFR Part 107(a) transport hazardous waste.
    a. Provide certifications that each vehicle dedicated to haul hazardous waste has been assigned a "U.S. DOT Hazardous Material Registration Number" as required by 49 CFR Part 107.
    b. Be responsible for all other applicable permits pertaining to hauling, transport, reduction, and disposal of hazardous waste as they may apply to this project.
    c. Vehicle: Ensure that all non-hazardous waste is transported in covered vehicles to a landfill, or lined landfill, if required.
    d. Container Handling: Carefully place the containers into the truck or dumpster used for disposal. At no time shall debris or containers be thrown or dropped.
    e. Liquid Wastes: Contain and properly dispose of all liquid wastes, including lead-contaminated wash water.
    f. Containers: HEPA vacuum the exterior of all waste containers prior to removing the waste containers from the work area. Wet wipe the containers to ensure that there is no residual contamination. Then move containers out of the work area into the designated storage area.

I. Clearance
1. Clearance on all abatement projects must be done by an independent certified risk assessor or inspector technician. Follow all jurisdictional law with regard to licensure requirements for personnel conducting clearance activities.
2. Clearance step-by-step procedures are as follows:
    a. Finish the lead hazard control clean-up effort. Seal floors before clearance (if necessary).
    b. Wait 1 hour to allow any airborne dust to settle. Do not enter work area during that hour.
    c. Conduct visual examination
        1) Determine if all required work has been completed and all lead-based paint hazards have been controlled.
        2) Determine if there is visible settled dust, paint chips, or debris in the interior or around the exterior.
    d. Complete the Visual Clearance Form required by the the Owner; if all work is not completed inform the the Owner and order completion of the work and repeat cleanup, if necessary.
    e. Conduct clearance dust sampling of the floors, interior window sills, and window troughs using approved protocol.
    f. Conduct soil sampling if bare soil is present that was not sampled previously, or if exterior paint work was completed as part of the lead hazard control effort. Whenever exterior work has been don, it may be necessary to take samples from the soil that is not bare to determine if contamination has occurred. If results are above 1,000 µg/g (or 400 µg/g in high contact play area), compare the results to baseline soil sampling results to determine what additional measures are needed.
    g. Complete the Dust and Soil Sampling Clearance Form required by the the Owner.

h. Submit samples to a U.S. Environmental Protection Agency (EPA) recognized laboratory participating in the National Lead Laboratory Accreditation program (NLLAP) for analysis.
i. Interpret results by comparing them to Interim Clearance Standards as listed below:
   1) Floors 400 µg/ft2
   2) Window sills 250 µg/ft2
   3) Window Troughs 800 µg/ft2
   4) Soils (Play area with children under 6 years of age) 400 µg/gram
j. If clearance is achieved go to step N.
k. Order repeated cleanings or soil treatments if results are above applicable standards. Clean all surfaces the sample represents.
l. Continue sampling and repeated cleanings until the dwelling achieves compliance with all applicable clearance standards.
m. Complete any related construction work that does not disturb a surface with lead-based paint (all work that does disturb painted surfaces or that could generate lead dust should be completed as part of the lead hazard control effort).
n. Issue any necessary statements of lead-based paint compliance or releases and maintain appropriate records.

J. Labels
1. Use the following labels on drums used for disposal.

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.

IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

GENERATOR INFORMATION:

NAME _____

ADDRESS _____ PHONE _____

CITY _____ STATE ____ ZIP _____

EPA ID NO. / MANIFEST DOCUMENT NO. _____ / _____

ACCUMULATION START DATE _____ EPA WASTE NO. _____

HAZARDOUS WASTE, SOLID, N.O.S.

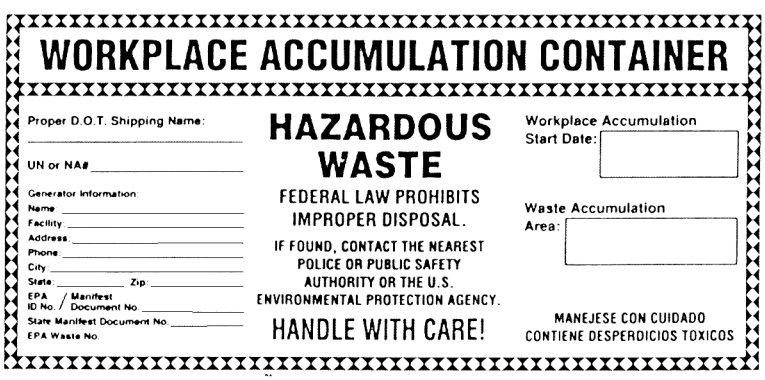
( )

NA3077

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

HANDLE WITH CARE!

STYLE HWM12



WORKPLACE ACCUMULATION CONTAINER

Proper D.O.T. Shipping Name: _____

UN or NA# _____

Generator Information:
Name: _____
Facility: _____
Address: _____
Phone: _____
City: _____
State: _____ Zip: _____
EPA ID No. / Manifest Document No. _____
State Manifest Document No. _____
EPA Waste No.

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.

IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

HANDLE WITH CARE!

Workplace Accumulation Start Date: _____

Waste Accumulation Area: _____

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CONTIENE DESPERDICIOS TOXICOS

K. Disposal of lead-based paint waste.

1. Follow the RCRA and HUD recommended practices as defined in the table below:

Waste Management Practices	Category I: Low Lead Waste	Category II: Architectural Components	Category III: Concentrated Lead Waste	Category IV: Other waste
RCRA Requirements	Manage as nonhazardous Waste	Depending upon knowledge or TCLP testing results, manage as solid hazardous or nonhazardous waste	If more than 100 kg/ month, manage as hazardous waste. If less than 100 kg/month manage as solid waste.	Use TCP to determine if waste is hazardous.
HUD Recommended Practices	Applicable	Applicable, if knowledge or TCLP testing indicates that it is nonhazardous.	Applicable if less than 100 kg/month otherwise subject to full RCRA regulations	Only applicable if TCLP testing shows waste is nonhazardous
Wrapped in plastic; seal all seams with tape (if acceptable to the disposal facility).	X	X	X	X
Stored in designated, secure area.	X	X	X	X
Covered During Transport	X	X	X	X
Prohibit cutting/breaking outside work area.	X	X	X	X
Cover ground with 6-mil plastic if handling outside.	X	X	X	X
Prohibit disposal in solid waste incinerators and reuse recycling for mulch	X	X	X	X
Recommended disposal in State licensed/permitted	X	X	If appropriate.	X

solid waste landfill.				

L. Safety Requirements
1. To protect the health and safety of all persons involved, it is of the utmost importance that deleading is safely and correctly done in a timely manner. The following specific safety requirements are the responsibility of the Deleading Contractor.

K. General Safety:
1. General
   a. NO ONE is to be allowed in the work area without an approved respirator except for methods that have been documented not requiring a respirator.
   b. Each work area must be sealed from the remainder of the dwelling by taping plastic sheets (6 mil thick). Work areas must remain sealed off until both work and clean-up are completed.
   c. Cover all floors, carpets, furniture and appliances with 6 mil plastic within the work area. Use automotive masking tape (2 inches wide) to seal all edges and seams.
   d. Make certain all electrical connections are properly grounded.
   e. At least three days prior to the start of any deleading work, post appropriate warning signs at all entrances and exits of work areas and leave in place until all clearance testing indicates that these areas are safe for re-occupancy. The signs must include the following phrase: "CAUTION LEAD HAZARD-KEEP OUT". Post bilingual signs when necessary.
2. Worker Safety: The Deleading Contractor shall take the following minimum precautions to protect the health of all individuals involved in the deleading process.
   a. Pre-Abatement Medical Exam: Each employee shall undergo a medical examination to determine both respiratory fitness capability and also pre-existing/current blood lead level. Said results shall be provided to the employee and also to the Owner within 3 days of receipt of same, and in all cases, prior to employee's commencement to active abatement. Records of same are required to be kept by the Contractor for 40 years.
   b. Medical Surveillance is the monitoring of worker blood levels. It is required that the Contractor have blood level monitoring of all active abatement and clean-up workmen and on-site supervisors performed and said results provided to the Owner.
      1) Before assignment to active abatement activity for each worker.
      2) 30 days after active abatement has begun.
      3) At least every two months during the first six months and every six months throughout the deleading job.
      4) At least every two months for each employee whose blood lead analysis indicated a blood lead level at or above 25 micrograms per deciliter. (20 micrograms per deciliter for women of child bearing age).
      5) At termination of employment.
      6) Contractor shall reassign any employee whose blood lead has reached 25 µg/dl (20 µg/dl for women of child bearing age) to a job function deemed safe from lead exposure. Said employee shall remain away from active abatement until such time as 2 consecutive months' blood tests indicate µg/dl below 20 µg/dl.
   c. Respiratory Protection Programs must be established by the Contractor in accordance with OSHA regulations and qualitative respirator fit testing must be conducted daily by the on-site supervisor. Medical examinations must be performed by a physician prior to fit testing and at anytime when a worker demonstrates any difficulty breathing during the use of or the fit testing of respirators. The following are minimal acceptable respiratory protection program requirements as set up and administered by the Contractor:
      1) Written standard operating procedures which oversees the selection and use of respirators.
      2) Selection of respirators on the basis of hazards to which the worker is exposed.
      3) Worker training on the limitations and use of respirators (includes fit testing).
      4) Individual workers assigned respirators for their exclusive use only.

5) Daily cleaning and disinfecting of respirators.
6) Proper storage of all respirators.
7) Proper inspection of all respirators for wear and tear.
8) Continual surveillance of work area conditions and level of worker exposure or stress.
9) Use of approved respirators only, modified as needed by the weekly exposure monitoring results.
10) Supply weekly report covering items 1-9 to the Owner or its Lead Consultant.

d. Exposure Monitoring is the measured concentration of lead in the workers breathing zones. The Contractor shall perform personnel monitoring during active abatement using the NIOSH 7072 method and-shall be responsible for:
1) Monitoring the level of worker protection needed during the abatement process;
2) Evaluating, modifying and improving any engineering and work practice control(s) as needed;
3) Evaluating each employee's personal quality of work and any need for additional worker training or safety instruction;
4) Providing the Owner results of all personnel monitoring tests within 10 days of testing; and
5) Providing half-face APR respirators with HEPA filters unless said monitoring test results dictate differently. OSHA guidelines shall be used to determine respirator PEL protection factors.

e. Protective Clothing Equipment must be provided to all workers to help assure that lead dust is contained to the work areas. The following must be supplied/enforced by the Deleading Contractor:
1) Full body protective clothing and shoe covers of appropriate sizes on a daily basis or as needed.
2) Clean changing areas separated from the dirty/contaminated clothes storage area.
3) Water and wash facilities for washing of hands and face and shower facilities if deemed necessary by the Owner's Lead Advisor.
4) Instructing worker on proper maintenance of clothing and equipment.
5) Proper disposal of disposable clothing and proper permanent work clothes.
6) Enforcing the removal of protective clothing at the end of each work day and before eating, drinking and smoking.
7) Enforcement of the removal of protective shoe covers before leaving work area.

3. Contractor/Worker Daily Safe-Work Procedures
a. Daily Start-Up:
1) Workers to put on protective gear prior to entering work areas.
2) All garment seams to be sealed with duct tape.
3) All non-working garments must be stored in designated changing area.
4) Respirators, as required, must be properly fitted before entering work area. Perform qualitative fit test.

b. Temporary depart:
1) All protective clothing to be HEPA vacuumed while still being worn.
2) All shoe covers to be removed and left in the work area (immediate departure upon removing).
3) Remove all protective gear in designated "contaminated" changing area before eating, drinking, and smoking or before leaving work site.
4) Wash hands and face.
5) Clean respirators.

c. Daily Shut-Down:
1) Dispose of protective clothing with abatement waste by sealing in a 6 mil poly bag.
2) Laundered clothes must be placed in closed container.
3) Wash hands and face.
4) Shower if facilities allow and circumstances dictate.
5) Clean all protective gear (respirators included).

4. Tenant's Safety: Temporary relocation of the tenants is necessary if the lead paint surface is broken. Temporary relocation of the tenants and their belongings is the responsibility of the Owner. However, the Contractor has the joint responsibility to administer and enforce the following safety practices on behalf of the occupants:
   a. Adults
      1) NO OCCUPANT is allowed to enter the work area during paint removal and initial clean-up. A three day clean-up and settlement period may be imposed depending upon the abatement procedures used, at the discretion of the Owner or their Lead Consultant.
      2) the Owner shall notify all occupants in writing when they are allowed to return to their post-abated residence. Contractor shall abide by these notices.
      3) Every resident who has received prior notice of abatement is responsible for placing all personal items (clothing, dishes, linens, etc.) in closed, easy to handle containers; and move such items to the center of each room as requested.
      4) As long as visible dust remains, occupants may not occupy dwelling, and all surfaces within the dwelling must be re-washed with trisodium phosphate and HEPA vacuumed by deleading contractor.
      5) Persons reoccupying dwellings following abatement are required to report any visible dust or debris to the Owner immediately for additional Contractor clean-up.
   b. Pregnant Women and Children
      1) Absolutely no pregnant women nor children under the age of twelve years of age may be allowed in the building while any part of the abatement process is going on.

END OF SECTION 02 83 00 00

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SECTION 02 83 19 00 - LEAD-BASED PAINT REMEDIATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the removal and disposal of lead-based or lead-containing paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions

1. Action Level: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in an occupational/industrial environment.
2. Area Sampling: Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.
3. Competent Person (CP): As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. An industrial hygienist or safety professional certified for comprehensive practice by the American Board of Industrial Hygiene or by the Board of Certified Safety Professionals is the best choice.
4. Contaminated Room: Room for removal of contaminated personal protective equipment (PPE).
5. Decontamination Shower Facility: That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.
6. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.
7. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.
8. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps.
9. Lead-Based Paint (LBP): Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.
10. Lead-Based Paint Hazard (LBP Hazard): Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.
11. Lead-Containing Paint (LCP): Lead-based paint or other similar surface coating containing lead or lead compound in excess of 0.06 percent by weight of the total nonvolatile content of the paint.
12. Lead Control Area: An enclosed area or structure, constructed as a temporary containment equipped with HEPA filtered local exhaust, which prevents the spread of lead dust, paint chips, or debris existing as a condition of lead-based paint removal operations. The lead control area is also isolated by physical boundaries to prevent unauthorized entry of personnel.
13. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a work day, the PEL shall be determined by the following formula:

    PEL (micrograms/cubic meter of air) = 400/No. hrs. worked per day.
14. Personal Sampling: Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches (150 to 225 mm) and centered at the nose or mouth of an employee.

15. Physical Boundary: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside boundary."

C. Submittals: Submit the following:
   1. Product Data:
      a. Vacuum filters
      b. Respirators
   2. Test Reports
      a. Sampling results
      b. Assessment data report
   3. Certificates
      a. Qualifications of CP
      b. Testing laboratory</SUB> qualifications
      c. Third party consultant qualifications
      d. Lead-Based Paint/Lead-Containing Paint Removal Plan including CP approval (signature, date, and certification number)
      e. Rental equipment notification
      f. Respiratory protection program
      g. Hazard communication program
      h. EPA approved hazardous waste treatment or disposal facility for lead disposal
      i. Hazardous waste management plan
      j. Vacuum filters
   4. Manufacturer's Instructions
      a. Chemicals and equipment
      b. Materials
      c. Safety data sheets for all chemicals
   5. Closeout Submittals
      a. Completed and signed hazardous waste manifest from treatment or disposal facility
      b. Certification of medical examinations
      c. Employee training certification

D. Qualifications Of CP
   1. Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained and licensed and certified in accordance with Federal, State, and local laws.

E. Third Party Consultant Qualifications
   1. Submit the name, address, and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead in dust or soil sampling. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

F. Testing Laboratory
   1. Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe and soil sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis.

G. Lead-Based Paint/Lead-Containing Paint Removal Plan (LBP/LCPRP)

1. Submit a detailed job-specific plan of the work procedures to be used in the removal of LBP/LCP. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air and baseline lead dust/soil concentrations are not reached or exceeded outside of the lead control area. Include site preparation and cleanup procedures. Include occupational and environmental sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan.

H. Occupational And Environmental Sampling Results
1. Submit occupational and environmental sampling results to the the Owner within three working days of collection, signed by the testing laboratory responsible official, the employee that performed the sampling, and the CP.
   a. The sampling results shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead.
   b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62.
   c. The initial monitoring shall determine the requirements for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCP) in accordance with 29 CFR 1926.62.

I. Occupational And Environmental Assessment Data Report:
1. Some LBP/LCP removal work may not require full implementation of the requirements of 29 CFR 1926.62. Based on the experience of the Contractor and/or the use of a specific process or method for performing the work, the Contractor may be able to provide historic data (previous 12 months) to demonstrate that airborne exposures are controlled below the action level. Such methods or controls shall be fully presented in the LBP/LCPRP. To reduce the full implementation of 29 CFR 1926.62, the Contractor shall provide documentation in an Assessment Data Report.
2. Submit occupational and environmental assessment report to the the Owner prior to start of work, signed by the testing laboratory responsible official, and the CP.
   a. Submit a report that supports the determination regarding the reduction of the need to fully implement the requirements of 29 CFR 1926.62 and supporting the LBP/LCP. The exposure assessment shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.
   b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62 with a complete process description in supporting a negative assessment.
   c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCPRP) in accordance with 29 CFR 1926.62.

J. Quality Assurance
1. Medical Examinations: Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103.

a. Medical Records: Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.
b. Medical Surveillance: Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62.

2. Competent Person (CP) Responsibilities
   a. Certify training as meeting all federal, State, and local requirements.
   b. Review and approve lead-based paint/lead-containing paint removal plan for conformance to the applicable referenced standards.
   c. Continuously inspect lead-based paint removal work for conformance with the approved plan.
   d. Perform air and wipe sampling.
   e. Ensure work is performed in strict accordance with specifications at all times.
   f. Control work to prevent hazardous exposure to human beings and to the environment at all times.
   g. Certify the conditions of the work as called for elsewhere in this specification.
3. Training: Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations.
   a. Training Certification: Submit a certificate for each employee, signed and dated by the approved training source, stating that the employee has received the required lead training.
4. Respiratory Protection Program
   a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62.
   b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.
5. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.
6. Hazardous Waste Management: The Hazardous Waste Management Plan shall comply with applicable requirements of federal, State, and local hazardous waste regulations and address:
   a. Identification and classification of hazardous wastes associated with the work.
   b. Estimated quantities of wastes to be generated and disposed of.
   c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact. Furnish two copies of EPA, or State and local hazardous waste permit applications or permits or manifests, as required, and EPA Identification numbers.
   d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
   e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
   f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.
   g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
   h. Unit cost for hazardous waste disposal according to this plan.
7. Environmental, Safety and Health Compliance: In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the the Owner for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

8. Pre-Construction Conference: Along with the CP, meet with the the Owner to discuss in detail the hazardous waste management plan and the lead-based paint/lead-containing paint removal plan, including work procedures and precautions for the removal plan.

K. Equipment
1. Respirators: Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.
2. Special Protective Clothing: Furnish personnel who will be exposed to lead-contaminated dust with proper disposable uncontaminated, reusable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.
3. Rental Equipment Notification: If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the the Owner.
4. Vacuum Filters: UL 586 labeled HEPA filters.
5. Equipment for Owner's Personnel: Furnish the the Owner with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. Respiratory protection for the the Owner will be provided by the Owner.

L. Removal
1. Title to Materials: Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Division 2 Section "Selective Structure Demolition", "Structure Demolition", except as specified herein.

1.2 PRODUCT

A. Chemicals
1. Submit applicable Safety Data Sheets for all chemicals used in paint removal work. Use the least toxic product approved by the the Owner.

B. Materials
1. The soluble metal content and the total metal content shall not exceed values which would cause a material to be classified as a hazardous waste.

1.3 EXECUTION

A. Protection
1. Notification: Notify the the Owner 20 days prior to the start of any paint removal work.
2. Lead Control Area Requirements
   a. If LBP will be removed by means which will not likely create airborne, lead-containing dust (such as careful wet scraping or chemical stripping), establish a lead control area by situating critical barriers and physical boundaries around the area or structure where LBP/LCP removal operations will be performed.
   b. If removal practice will create airborne, lead-containing dust (such as sanding, abrasive blasting, thermal cutting, demolition, or needle gun use), utilize full containment procedures - Contain removal operations by the use of critical barriers and HEPA filtered exhaust **OR** a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust if required by the CP, **as directed**. For containment areas larger than 1,000 square feet (100 square meters) install a minimum of two 18 inch (450 mm) square viewing

ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.

3. Protection of Existing Work to Remain: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.
4. Boundary Requirements: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
   a. Physical Boundary: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
   b. Warning Signs: Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.
5. Furnishings:
   a. The Owner will remove furniture and equipment from the building before lead-based paint removal work begins.
      OR
      Furniture and equipment will remain in the building. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the the Owner.
      OR
      Existing furniture and equipment is lead contaminated, decontaminate, dispose of as lead contaminated waste.
6. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil (0.15 mm) plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.
7. Decontamination Shower Facility: Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.
8. Eye Wash Station: Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.
9. Mechanical Ventilation System
   a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.
   b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.
   c. Vent local exhaust outside the building only and away from building ventilation intakes.
   d. Use locally exhausted, power actuated, paint removal tools.
10. Personnel Protection: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

B. Work Procedures: Perform removal of lead-based paint in accordance with approved lead-based paint/lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, State, and local requirements.
   1. Personnel Exiting Procedures: Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.
b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.
c. Shower **OR** Wash hands and face at the site, **as directed**, don appropriate disposable or uncontaminated reusable clothing; move to an appropriate facility; shower.
d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

2. Air and Wipe Sampling
   a. Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.
      1) The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal work to ensure that the requirements of the contract have been satisfied during the entire lead-based paint removal operation.
      2) Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
      3) Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken. Notify the the Owner immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
      4) For high profile, sensitive work such as present in family housing, child care facilities, administrative buildings, kitchens, barracks, etc., surface dust sampling to determine clearance (i.e., that the work has not contaminated surfaces within and adjacent to the control area) should be performed by a third party to reduce a conflict of interest. Samples must be conducted by an individual not paid or employed or otherwise compensated by the LBP/LCP removal Contractor. State or local regulations may require third party testing if the LBP/LCP removal operation is considered a lead hazard reduction activity.
      5) Before any work begins, collect and analyze baseline or soil wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal.
   b. Air Sampling During Paint Removal Work: Conduct area air sampling daily, on each shift in which lead-based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the the Owner immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after approval is given by the CP and the the Owner. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3. Lead-Based Paint Removal
   a. Manual or power sanding of interior and exterior surfaces is not permitted. Provide methodology for removing LBP in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.
   b. Avoid flash rusting or deterioration of the substrate. Provide surface preparations for painting in accord with Division 7.
   c. Provide methodology for removing LBP/LCP removal processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this LBP/LCP removal process in the LBP/LCPRP.

d. Indoor Lead Paint Removal: Perform manual **OR** mechanical **OR** thermal **OR** chemical, **as directed**, paint removal in lead control areas using enclosures, barriers, or containments and powered locally exhausted paint removal tools. Collect residue and/or debris for disposal in accordance with federal, State, and local requirements.

e. Outdoor Lead Paint Removal: Perform outdoor removal as indicated in federal, State, and local regulations and in the LBP/CPRP. The worksite preparation (barriers or containments) shall be job dependent and presented in the LBP/LCPRP.

f. Sampling After Paint Removal: After the visual inspection, conduct soil sampling if bare soil is present during external removal operations and collect air samples inside and outside the lead control area to determine the airborne levels of lead inside and outside the work area. Collect wipe samples according to the HUD protocol contained in HUD Guidelines to determine the lead content of settled dust and dirt in micrograms per square foot (square meter) of surface area and parts per million (ppm) or micrograms per gram (µg/g) for soil.

4. Cleanup and Disposal

a. Cleanup: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

b. Clearance Certification

1) The CP shall certify in writing that the final air samples collected inside and outside the lead control area are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the the Owner's acknowledgement of receipt of the CP certification.

2) A third party consultant shall certify surface wipe sample results collected inside and outside the work area are less than 100 micrograms per square foot (0.1 square meter) on uncarpeted floors, less than 500 micrograms per square foot (0.1 square meter) on interior window sills and less than 800 micrograms per square foot (0.1 square meter) on window troughs **OR** not significantly greater than the initial surface loading determined prior to work, **as directed**.

3) For exterior paint removal work, soil samples taken at the exterior of the work site shall be sued to determine if soil lead levels had increased at a statistically significant level (significant at the 95 percent confidence limit) from the soil lead levels prior to the work. If soil lead levels do show a statistically significant increase above any applicable Federal or State standard for lead in soil, the soil shall be remediated back to the pre-work level.

c. Testing of Lead-Based Paint Residue and Used Abrasive: Test paint residue and used abrasive in accordance with 40 CFR 261 for hazardous waste.

d. Disposal

1) Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 261. Dispose of lead-contaminated waste material at an EPA or State approved hazardous waste treatment, storage, or disposal facility off Owner’s property.

2) Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon (208 liter) drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The the Owner or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.
3) Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
4) All material, whether hazardous or non-hazardous shall be disposed in accordance with laws and provisions and Federal, State, or local regulations. Ensure waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

5. Disposal Documentation: Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and State or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.
6. Payment for Hazardous Waste: Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Owner.

END OF SECTION 02 83 19 00

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SECTION 02 83 19 00a - XRF TESTING FOR LEAD-BASED PAINT

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for XRF testing for lead-based paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 SUMMARY

A. The Contractor shall perform work in accordance with the latest HUD Guidelines, in accordance with all applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any applicable State or Local standards that may be more stringent than the Federal Standards except, as such guidelines are modified by the Owner in writing in this contract or any contract pursuant to this contract.

B. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.

1.3 SUBMITTALS

A. Notification Before Start of Work
   1. The Contractor shall send notices to the Project Superintendent, Residents, and the Department of Planning and Development 48 hours before the scheduled start of work. The Contractor shall make three (3) attempts to gain entry to each apartment, with proper 48 hour notification to the resident each time.
   2. The Contractor shall begin work no later than 48 hours after receiving a work proceed order.

B. Copies of the submissions listed below must be tendered with the bid:
   1. Ability to perform XRF testing and paint chip sampling by submitting evidence of the successful completion of lead inspector training by all staff to be assigned to the job including inspector technicians. Training must be provided through a State approved EPA-Model program. All staff assigned to the Contract must also demonstrate training in the use of the XRF testing machines to be dedicated to this contract. The serial number of such XRF machine shall be provided to the the Owner.
      a. Contractor or Subcontractor performing the work must have at least 3 years of satisfactory experience (documented) in performing XRF testing for a City, State or Federal Agency.
   2. Laboratory certification by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
   3. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated above must also be provided for the subcontractor.

C. XRF Testing Report Format

a. All XRF report must be made after a formal submittal and approval by the Owner.
b. A faxed summary report must be provided to the the Owner within 48 hours after completion of testing for a work Authorization. For XRF testing requiring confirmation by laboratory analysis of paint chip samples, the faxed summary report must be provided within 48 hours after the the Owner gives approval for testing of the collected paint chip samples.
c. A detailed report must be provided to the the Owner within 5 business days after completion of the testing.

1.4 QUALITY ASSURANCE

A. The work shall consist of furnishing all labor, material, insurance and all other incidental items required to do the following:
1. XRF Testing
a. Random or comprehensive testing of various components in single family housing units, multi-family housing units, common areas and exterior sites, using any of the approved X-ray Fluorescence ("XRF") machines, to determine if the lead-based paint concentration is within permissible limits.
Note: Testing may be for entire apartments or selected rooms or components within the apartment.
b. The permissible limit shall be defined as a final reading showing a lead concentration of less than 1.0 mg/cm².
c. Refer to the Manufacturer's manual, as well as the "XRF Performance Characteristic Sheet" when determining calibration check tolerance, and other instrument specific information. Use the adjusted "XRF Performance Characteristic Sheets" in this contract when determining the inconclusive range.
d. In addition to the manufacturer's recommended warm up and quality control procedures, a set of three nominal XRF calibration check readings must be taken before the inspection begins and after the inspection has been completed in a particular unit, or every 4 hours, whichever occurs first. All reference material values and calibration check readings must be included in the report provided to the Owner.
e. Do not use the XRF to test highly curved or ornate surfaces, or surfaces inaccessible to the XRF, due to poor reliability of results. For such surfaces, laboratory analysis of paint chips must be done.
f. Only one XRF reading is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
g. All inconclusive results must be treated according to the inspection rules using multi-family inspection or single family inspection rules as appropriate.
h. XRF field data sheets shall be filled out as they appear on completed Form 7.1(“Single-Family Housing LBP Testing Data Sheet”) and 7.5 (“"Multifamily Housing LBP Testing Data Sheet”) in HUD Guidelines.
i. Room equivalents or sections thereof that are not accessible for testing (i.e. locked bedrooms) shall be noted in the final report to the Owner.
2. Laboratory testing of paint chips.
a. Collection of paint chips from various painted components for laboratory analysis due to XRF substrate corrected inconclusive and/or positive readings as directed by the the Owner.

b. Laboratory preparation and testing by Flame Atomic Absorption Spectrometry (FAAS) or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) to determine if the lead paint concentration is within permissible limits.
c. The permissible limit shall be defined as a lead concentration less than 0.5% by weight.
d. Collect paint chips in accordance with ASTM ES28-94.
e. Prepare paint chips in the laboratory for testing in accordance with ASTM ES37-94.
f. Repair and repaint areas from which paint chips have been collected, to match adjacent areas, unless notified by the the Owner in writing to utilize a temporary covering for the tested surfaces. The Contractor shall provide water based latex paint for this purpose. Colors shall be limited to white and off-white; and other colors if provided by the tenant.
g. Only one paint chip is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate, and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
h. Field data sheets and signed chain of custodies must be attached to the final report to the Owner.

B. Occupied Residences
1. Some of the work of this contract will be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
2. The Contractor shall take all necessary precautions to protect the property of the the Owner, its residents and the public. The contractor must repair any damaged property, whether of the the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgement of the the Owner, match the existing materials and are of equal quality and workmanship. All such repairs shall be at the Contractor's expense.

C. Applicable Regulations
1. ASTME Standards
a. ASTM E 1583 on evaluating laboratories used to determine lead levels;
b. ASTM E 1605 on terminology;
c. ASTM E 1613 on determining lead by atomic emission or atomic absorption spectroscopy;
d. ASTM E 1645 on laboratory preparation of paint-chip samples;
e. ASTM E 1775 on-site extraction and field portable stripping voltammetry analysis for lead;
f. ASTM PS 53 on identifying and managing lead in facilities;
g. ASTM PS 87 on ultrasonic extraction for later analysis for lead;
h. ASTM PS 88 on determining lead by portable electro analysis
2. OSHA Standards (without limitation), include:
a. 29 CFR 1926.20 - General safety and health provisions;
b. 29 CFR 1926.21 - Safety training and education;
c. 29 CFR 1925.25 - Housekeeping;
d. 29 CFR 1926.28 - Personal protective equipment;
e. 29 CFR 1926.51(f) - Washing facilities;
f. 29 CFR 1926.55 - Gases, vapors, fumes, dusts, and mists;
g. 29 CFR 1926.57 - Ventilations;
h. 29 CFR 1926.59 - Hazardous Communication Standards;
i. 29 CFR 1926.10 - Respiratory protection; and
j. 29 CFR 1926.62 - Lead in Construction
3. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).

4. The Contractor must follow the XRF Performance Characteristic Sheet (PCS) for all inspection activities. XRF PCSs are available from the National Lead Information Center Clearinghouse or through the HUD website at http://www.hud.gov/offices/lead/lbp/hudguidelines/allpcs.pdf.

1.5 PRODUCTS

A. XRF Instruments and Testing Protocols
1. The Contractor shall use XRF instruments that are approved by the Owner.
2. XRFs must be used in accordance with the manufacturer's instructions and the XRF Performance Characteristic Sheet. If discrepancies exist between the XRF Performance Characteristic Sheet, the HUD Guidelines and the manufacturer's instructions, the most stringent guidelines should be followed.

1.6 EXECUTION

A. Inspection and Testing
1. Single Family Testing Rules
a. If the housing development has less
1) than 10 units built between 1960-1970 or
2) 20 units built before 1960 or
3) the random testing rules in a multi-family development are not being used then single family testing rules must be followed.
b. List all testing combinations (see HUD Guidelines Table for an example) in all interior rooms, on all exterior building surfaces, and on surfaces in other exterior areas, such as fences, playground equipment, and garages. The “SingleFamily Housing LBP Testing Data Sheet” (see HUD Guidelines) or a comparable data collection instrument may be used for this purpose.
1) Test all room equivalents inside and outside the dwelling unit. The final report must include a final determination of the presence or absence of lead-based paint on each testing combination in each room equivalent.
2) Inspect each testing combination in each room equivalent, unless similar building component types with identical substrates (such as windows) are all found to contain lead-based paint in the first five interior room equivalents. In that case, testing of that component type in the remaining room equivalents may be discontinued, if and only if the Owner agrees beforehand to such a discontinuation. The inspector should then conclude that similar building component types in the rest of the dwelling unit also contain lead-based paint.
3) Painted furniture that is physically attached to the unit (for example, a desk or dresser that is built-in) should be included in the inspection as a testing combination.
4) Results of an inspection may be summarized by classifying component types across room equivalents if patterns or trends are supported by the data.
5) All substrates across all room equivalents should be grouped into one of the six substrate categories (brick, concrete, drywall, metal, plaster, or wood).
c. Number and Location of XRF Readings
1) XRF testing is required for at least one location per layers of paint should be included and the XRF probe testing combination, except for interior and exterior faceplate should be able to lie flat against the surface walls, where four readings should be taken, one on of the test location each wall.
2) For interior and exterior walls: take at least four readings (one of ea. wall). If there are more than four walls test the four largest walls, calculate the average of the

readings, round the result to same number of decimal places as the XRF instrument displays, and classify the remaining walls with the same painting history as the tested walls, based on this rounded average. When the remaining walls in a room equivalent clearly do not have the same painting history as that of the tested walls, test and classify the remaining walls individually.

3) Select areas of paint which are most likely to have old paint or coatings, where areas of paint appear thickest. Avoid testing where paint has worn away, chipped; or over pipes, electrical surfaces, nails, and any other possible interferences.

4) A numbering system, floor plan, sketch or other system may be used to document which testing combinations were tested and sufficiently detailed enough for another individual to find them.

a) Side identification Identify perimeter wall sides with letters A, B, C, and D (or numbers or Roman numerals). Side A for single-family housing is the street side for the address. Side A in multi-family housing is the apartment entry door side. Side B, C, and D are identified clockwise from Side A as one faces the dwelling; thus Wall B is to the left, Wall C is across from Side A, and Side D is to the right of Side A. Each room equivalent's side identification follows the scheme for the whole housing unit. Because a room can have two or more entries, sides should not be allocated based on the entry point. For example, giving a closet a side allocation based on how the room is entered would make it difficult for another person to make an easy identification, especially if the room had two closets and two entryways.

b) Room Equivalent Identification Room equivalents should be identified by both a number and a use pattern (for example, Room 5-Kitchen). Room 1 can always be the first room, at the A-D junction at the entryway, or it can be the exterior. Rooms are consecutively numbered clockwise. If multiple closets exist, they are given the side allocation: for example, Room 3, Side C Closet. The exterior is always assigned a separate room equivalent identifier.

c) Sides in a Room Sides in an interior room equivalent follow the overall housing unit side allocation. Therefore, when standing in any four-sided room facing Side C, the room's Side A will always be to the rear, Side B will be to the left, and Side D will be to the right.

d) Building Component Identification Individual building components are first identified by their room number and side allocation (for example, the radiator in Room 1, Side B is easily identified). If multiple similar component types are in a room (for example, three windows), they are differentiated from each other by side allocation. If multiple components are on the same wall side, they are differentiated by being numbered left to right when facing the components. For example, three windows on Wall D are identified as windows D1, D2, and D3, left to right. If window D3 has the only old original sash, it is considered a separate testing combination from the other two windows. Codes or abbreviations for building components and/or locations may be used in order to shorten the time needed for data entry. If codes or abbreviations are used, the inspection records and the inspection report must include a table showing their meaning.

d. XRF Instrument Reading Time

1) The recommended time to open an XRF instrument's shutter to obtain a single XRF result for a testing location depends on the specific XRF instrument model and the mode in which the instrument is operating. Follow manufacturer's instructions per HUD Guidelines.

e. XRF Calibration Check Readings

1) Follow manufacturer's instructions per HUD Guidelines.

f. Substrate Correction

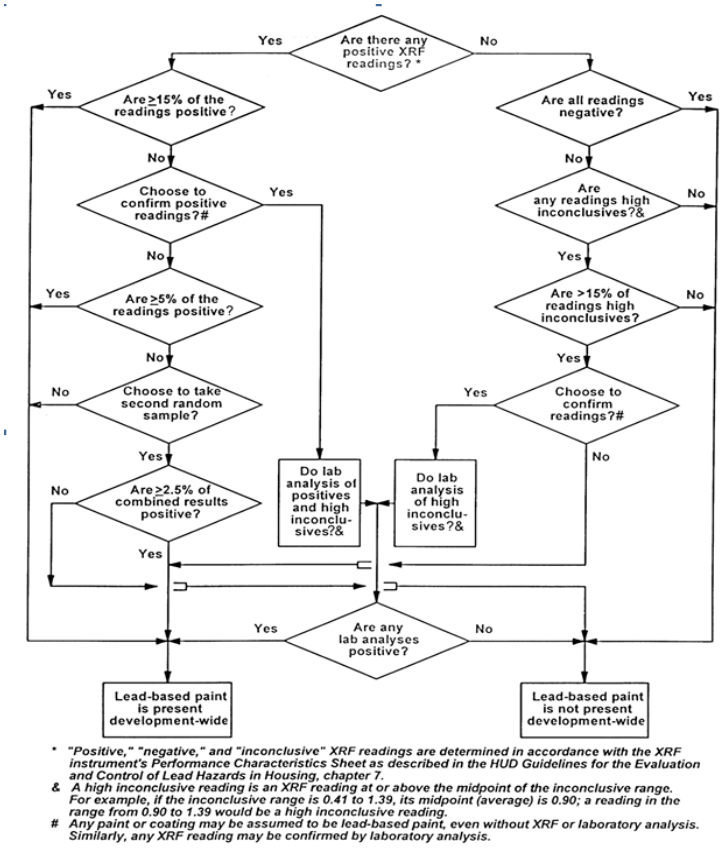
1) The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:

a) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.

b) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.

c) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.

g. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



1)

2) All inconclusive results must be confirmed with laboratory analysis, or as an alternative must be classified as positive. the Owner may also wish to confirm positive XRF results with laboratory analysis. Therefore the Contractor must make a field determination of which XRF readings falls in the inconclusive or positive ranges and take paint chip samples during the XRF testing for possible laboratory analysis. If the majority of XRF readings are positive in the first few units, the inspector must consult with the Owner on whether to continue taking paint chip samples. Only the Owner may determine whether to submit collected paint chip samples for laboratory analysis or to classify the element as positive.

2. Multi-family Housing Testing Rules (Random Sampling)

a. In order to use the Multi-family housing testing rules, there must multi-family housing is defined as any group of more than four units that are similar in construction from unit to unit

b. Determine the number of randomly selected units to be tested in accordance with Table 7.3, below. Chapter 7 of the HUD Guidelines also describes how to select the units randomly. If a unit or units which were selected as part of the original random sample cannot be entered for a particular reason, a replacement unit(s) must be randomly selected in accordance with the HUD Guidelines.

Table 7.3 Number of Units to be Tested in Multi-family Building or Developments*

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
1-10	All	All
11-13	All	10
14	All	11
15	All	12
16-17	All	13
18	All	14
19	All	15
20	All	16
21-26	20	16
27	21	17
28	22	18
29	23	18
30	23	19
31	24	19
32	25	19
33-34	26	19
35	27	19
36	28	19
37	29	19
38-39	30	20
40-48	31	21
49-50	31	22
51	32	22
52-53	33	22
54	34	22
55-56	35	22
57-58	36	22
59	37	23
60-69	38	23
70-73	38	24
74-75	39	24
76-77	40	24

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
78-79	41	24
80-88	42	24
89-95	42	25
96-97	43	25
98-99	44	25
100-109	45	25
110-117	45	26
118-119	46	26
120-138	47	26
139-157	48	26
158-159	49	26
160-177	49	27
178-197	50	27
198-218	51	27
219-258	52	27
259-279	53	27
280-299	53	28
300-379	54	28
380-499	55	28
500-776	56	28
777-939	57	28
940-1004	57	29
1005-1022	58	29
1023-1032	59	29
1033-1039	59	30
1500	87	44
2000	116	58
2500	145	73
3000	174	87
3500	203	102
4000	232	116

* For brevity, "Number of Units" and "Number of Units to Test" are used, but the number to test is the same for similar units, similar common areas, and similar exterior sites.

c. An assessment on each tested component must note four attributes, also called a testing combination.
   1) The room equivalent (where the testing took place i.e. bedroom, bathroom, etc.)
   2) The component type (door, wall #1 - upper left, etc.)
   3) The substrate (brick, wood, concrete, drywall, plaster or metal).
   4) The color of the paint.

d. These attributes must be included as part of the report.

e. For each testing combination, the condition of the painted surfaces should be noted as either intact, fair or poor.

f. One reading with the X-ray fluorescence (XRF) instrument on each testing combination is all that is required.

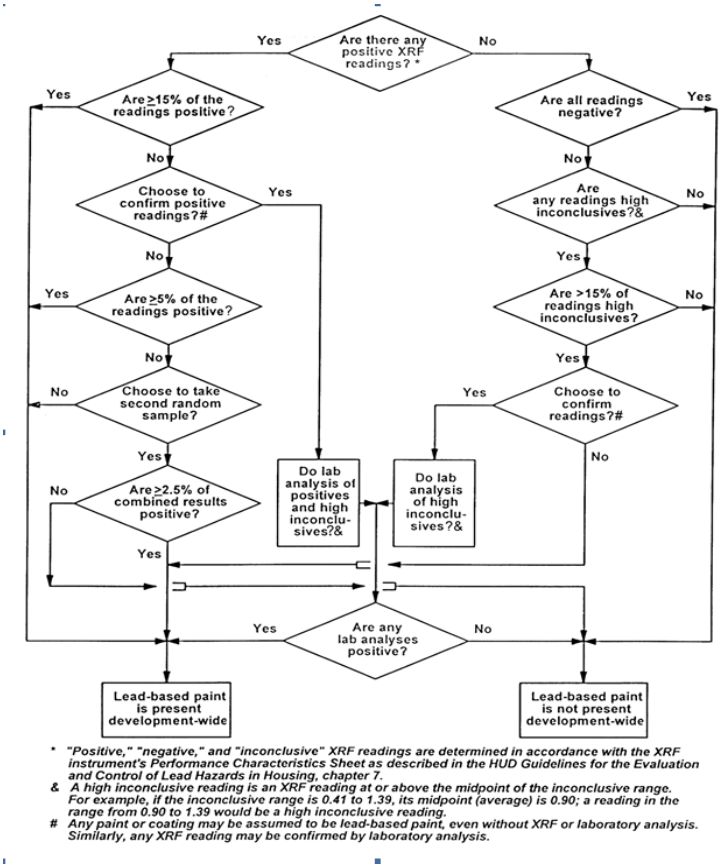
g. At least 40 components of a given type must be tested to obtain the desired level of confidence in the results throughout the multi-family development. If less than 40 components of a given type exist in the buildings to be tested i.e. they are unique components, then the measurement should be taken using single family testing rules (described below). If less than 40 components of a given type exist in the units to be tested, additional components of this type can be identified in other units in the complex and tested to bring the total up to 40 so that multi-family testing rules can be used. The decision of which option the Contractor should use will be made by the the Owner.

h. To increase the number of tested components of a given type, testing combinations with different colors on the same component and substrate may be combined into a single component type. For example, if "wood doors" is the component type, all wood doors tested for lead-based paint could belong to the same component type, regardless of color.

i. A component type may be differentiated by color as long as there are 40 tested and there is a good reason for differentiation.

j. The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:
   1) Positive- A positive XRF reading in accordance with the XRF’s Performance Characteristic Sheet.
   2) Negative- A negative XRF reading in accordance with the XRF’s Performance Characteristic Sheet.
   3) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF’s inconclusive range, in accordance with the XRF’s Performance Characteristic Sheet.

k. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



l. If there are readings on a component type(s) equal to or greater than 1.0 mg/cm² and paint chip samples are submitted to the laboratory, there are two possible results:

1) If all lab samples on a component type are below 0.5% lead by weight, the component type can be classified as negative throughout the development.
2) If one or more lab results are positive, (equal to or greater than 0.5% lead by weight for a component) the the Owner will take one of three options:
   a) Treat the component type as positive throughout the development, or
   b) Test the component type throughout the development, or
   c) If 5% or less of the component type are positive, take a second random sample, just testing that component type.
3) If option 2)c) above is selected by the Owner and the combined results of the first and second random sample are less than 2½% positive, the following additional options are available depending on the results.
   a) If no positives are found in the second sample, no further testing is necessary. Those positives in the first random sample will be monitored/abated (not by this Agreement), but the rest of the component type can be classified as negative.

b) If positives are found on a component type in the second sample, the the Owner has the option to classify the component type as positive throughout the development or comprehensively test it.

c) If the combined results of the two random samples are equal to or greater than 2½%, the the Owner also has the option to comprehensively test the remaining components of that type or classify them as positive.

m. Paint Chip Sample Size: The Paint chip samples should be taken from a 4 square inch (25 square centimeter) area that is representative of the paint on the testing combination, as close as possible to any XRF reading locations and, if possible, unobtrusive. This area may be a 2" x 2" (5 x 5 centimeters) square, or a 1" x 4" (2.5 x 10 centimeters) rectangle, or have any other dimensions that equal at least 4 square inches (25 square centimeters). Regardless of shape, the dimensions of the surface area must be accurately measured (to the nearest millimeter or 1/16th of an inch) so that the laboratory results can be reported in mg/cm$^{2.}$ Results should be reported as percent by weight if the surface area cannot be measured accurately or if all paint within the sampled area cannot be removed. In these cases, lead should be reported in ppm or percent weight, not in mg/cm^2. Smaller surface area can be used if acceptable to the laboratory. (See ASTME 1729). In all cases those who take the samples should consult with the NLLAP recognized laboratory selected regarding the requirements for the submission samples for lead-based paint analysis.

n. If the the Owner decides to test in search of these hard-to-find components coated with lead based paint, the inspector must use the single family testing rules described in the previous section.

3. Common Areas and Exterior Sites Testing Rules

a. Similar common areas and similar exterior sites must always be tested, but in some cases they can be sampled in much the same way that dwelling units are. Common areas and building exteriors typically have a similar painting history from one building to the next. In multifamily housing, each common area (such as building lobby, laundry room, or hallway) can be treated as a dwelling unit. If there are multiple similar common areas, they may be grouped for sampling purposes I exactly the same way as regular dwelling units. However, dwelling units, common areas and exterior sites cannot be all mixed together in a single group. All testing combinations within each common area or building exteriors selected for testing must be inspected. This includes playground equipment, benches and miscellaneous testing combinations located throughout the development. The specific common areas and building exteriors to test should be randomly selected, in much the same way as specific units are selected using random numbers. The number of common areas to be tested should be taken from table 7.3 (HUD Guidelines). In this instance, common areas and building exteriors can be treated in the same way as housing units (although they are not to be confused with true housing units).

4. Unit and Common Area Drawings

a. Mark-ups of as built drawings depicting room equivalents that are tested must be provided as part of the report.

b. The Contractor should test in a clockwise path starting from the door through the space and room equivalents so that the approximate location of each component tested can be easily established by referencing the room equivalent and sides.

c. Each space must have a reference point (side A, B, C, D or wall 1, 2, 3 or 4). The wall with the door should always be referenced as wall 1 or side A. If there is more than one door, wall 1 or side A should be used to refer to the wall with the door through which the room is first entered when moving in a clockwise fashion through the unit.

B. Evaluation of the Inspection by the the Owner

1. The Contractor will be required to carry out retesting at no additional cost to the the Owner, after completion of the Inspection at each the Owner's development as described in the HUD Guidelines, for single family housing, multi-family housing and common areas. The the Owner shall randomly select the testing combinations to be retested and the Contractor shall perform the retesting using the same XRF instrument(s) which was/were used to take the original readings. An the Owner's inspector shall be present to observe all retesting. The retesting shall be limited to ten (10) testing combinations, and if necessary to repeat the retest, the testing combinations randomly selected for repeating the retest shall also be limited to ten.
2. If the retest tolerance limit computed from the information provided in the "XRF Performance Characteristics Sheet" (see HUD Guidelines) is exceeded, the retest will be repeated as described in the HUD Guidelines for single family, multi-family housing and common areas. If the retest tolerance limit is exceeded again, the the Owner may require the Contractor to retest the entire development at no additional cost to the the Owner, or the the Owner may withhold all payments and terminate its agreement with the Contractor.

C. Option to do Laboratory Testing only
1. The the Owner may, for a specific testing assignment, request in writing that the Contractor, when utilizing the multi-family housing testing rules for random sampling, or the single family housing testing rules, do all testing through laboratory analysis of paint chips rather than through XRF Spectrum Analyzer testing with laboratory confirmation as needed. Please note that under the single family housing testing rules, only one paint chip must be taken and analyzed for each component type.

D. Waste Disposal
1. All waste generated must be legally disposed in accordance with Federal, State and Local regulations.

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SECTION 02 83 19 00b - LEAD DUST WIPE, AIR AND TCLP SAMPLING AND ANALYSIS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for lead dust wipe, air and TCLP sampling and analysis. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions: Unless otherwise specified the following definitions shall apply:

1. **"Approved"**: shall mean approved by all public agencies having jurisdiction, and the Owner.
2. **"The Owner"**: shall mean the Owner and its designated authorized representatives.
3. **"Contractor"**: shall mean the firm that is awarded this contract and is responsible to ensure compliance with Federal, State and City regulations as well as these Contract documents.
4. **"Development or Project"**: a group of buildings in one or more designated geographical locations, owned or operated by the Owner and referred to by a common name by the Owner.
5. **"Dust Cleaning Firm"**: shall mean the contractor under a separate contract or the Owner responsible for cleaning of lead dust, as directed by the Owner, until the clearance levels are achieved, as defined in the "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995" or latest edition published by the United States Department of Housing and Urban Development (HUD).
6. **"Equal or Approved Equal"**: shall mean equal in the opinion of the Owner.
7. **"HUD"**: the United States Department of Housing and Urban Development.
8. **"HUD Guidelines"**: shall mean Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing issued by HUD'S Office of Lead-Based Paint Abatement and Poisoning Prevention in June 1995 except as such guidelines are later modified by HUD and/or modified by the Owner in writing pursuant to this contract.
9. **"Inspector"**: an individual who has completed training from an accredited program and been licensed or certified by the appropriate State or local agency to (1) perform inspections to determine and report the presence of lead-based paint on a surface-by-surface basis through on-site testing, (2) report the findings of such an inspection, (3) collect environmental samples for laboratory analysis, (4) perform clearance testing, and (5) document successful compliance with lead-based paint hazard control requirements or standards.
10. **"Lead-Based Paint"**: any paint, varnish, shellac, or other coating that contains lead equal to or greater than 1.0 mg/cm² as measured by XRF or laboratory analysis, or 0.5 percent by weight (5,000 µg/g, 5,000 PPM, or 5,000 mg/kg) as measured by laboratory analysis.
11. **"Lead-Based Paint Hazard"**: a condition in which exposure to lead from lead-contaminated dust, lead-contaminated soil or deteriorated lead-based paint would have an adverse effect on human health (as established by the EPA Administrator under Title IV of the Toxic Substance Control Act). Lead-based paint hazards include for example, deteriorated lead-based paint, leaded dust levels above applicable standards and bare leaded soil above applicable standards.
12. **"Lead-Based Paint Hazard Control"**: activities to control or eliminate lead-based paint hazards, including interim controls and complete abatement.
13. **"Lead-Contaminated Dust"**: surface dust in residences that contain an area or mass concentration of lead in excess of the standard established by the EPA Administrator, pursuant to Title IV of the Toxic Substance Control Act. Until the EPA standards are set, the HUD recommended clearance and risk assessment standards for leaded dust are 40 µg/ft² on floors, 250 µg/ft² on interior window sills, and 800 µg/ft² on window troughs.
14. **"Monitoring"**: shall refer to inspection to ensure compliance with all Federal, State and City Standards or guidelines, and contractual specifications.
15. **"Provide"**: shall mean furnish and install.

16. **"Risk Assessor"**: a certified individual who has completed training with an accredited training program and who has been certified to (1) perform risk assessments, (2) identify acceptable abatement and interim control strategies for reducing identified lead-based paint hazards, (3) perform clearance testing and reevaluations, and (4) document the successful completion of lead-based paint hazard control activities.

Applicable Regulations/References

17. The work conducted shall comply with all applicable Federal, State and City regulations. Applicable guidelines and standards listed in the scope of work include, but are not limited to:

24 CFR Parts 35,36,37	HUD Lead-Based Paint Regulations
Guidelines for the Evaluation and Control of Lead-Based Paint in Housing (HUD Guidelines June 1995) & 1997 Revisions	
29 CFR 1910	General Industry Standard
29 CFR 1910.1025	Lead Standard for General Industry
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1200	Hazard Communication
29 CFR 1910.245	Specification for Accident Prevention
29 CFR 1926	Construction Industry Standards
29 CFR 1926.20	General Safety & Health Provisions
29 CFR 1926.21	Safety Training & Education
29 CFR 1926.25	Housekeeping
29 CFR 1926.28	Personal Protective Equipment
29 CFR 1926.51	Washing Facilities
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts & Mists
29 CFR 1926.59	Hazard Communication Standard
29 CFR 1926.62	Construction Industry Lead Standard
29 CFR 1926.103	Respiratory Protection
40 CFR 61 Subpart A	General Provisions
40 CFR 241	Guidelines for the Land Disposal of Solid Waste
40 CFR 257	Criteria for the Land Disposal of Solid Waste
40 CFR 261/262	Waste Disposal Facilities & Practices
American National Standards Institute (ANSI) Z87.1	Eye Protection
ANSI Z88.2-80	Practices for Respiratory Protection
American Society For Testing Materials (ASTM)	All Applicable Standards

18. The contractor shall ensure that any programs, certifications, licenses or other documentation in accordance with the above and/or any other applicable Federal, State, and Local Regulations/Guidelines are provided.

Scope Of Work

19. The work shall consist of furnishing labor, materials, insurance and all other incidental items required to perform the following:
    a. Dust wipe sampling and analysis
        1) Collect dust wipe samples from various horizontal surfaces, such as floors, window sills, window troughs, etc., as directed by the Owner.
        2) Dust wipe samples shall be collected in accordance with ASTM ES30-94.
        3) Analyze dust wipe sample in the laboratory using Flame Atomic Absorption Spectrometry ("FAAS") or Graphite Furnace Atomic Absorption Spectrometry("GFAAS").
        4) Provide result of analysis in micrograms per square foot.

5) A faxed summary of results must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected dust wipe sample. Contractor shall also have the ability to provide results in 4 hours for clearance, following lead-based paint abatement work, if requested by the Owner. The sampling result must be provided in a form approved by the Owner and must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and an indication of pass or fail.
6) Turn-around time for results shall be counted from the time the Contractor performs collection of dust wipe samples to the time the results are actually presented to the Owner. This includes travel time from the site to the laboratory of the Contractor and back to the site.
7) A detailed final report covering the results of all dust wipe samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and indicate pass or fail in a form approved by the Owner. Also include in the report the method of analysis, i.e. "FAAS" or "GFAAS", and the detection limits. The laboratory test results in the final report must be signed by the Laboratory Director.
8) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
9) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.

b. Dust Spiked Samples
1) Provide dust spiked samples to the Owner. Dust spiked samples shall be prepared in accordance with the HUD Guidelines.

NOTE: These samples are separate from the ones required by the Contractor for its own QA/QC

2) Prepare dust spiked samples in a manner such that they are indistinguishable from the field samples.
3) Prepare dust spiked samples using the same lot as that to be used in the field.
4) Dust spiked samples shall be inserted into the sample stream, randomly, by the Owner Inspector.
5) Blind analysis of dust spiked samples must fall within 80%-120% of the true value. If the laboratory fails to obtain readings within these limits, two more spiked samples shall be sent immediately to the lab for analysis.
6) If the two additional spiked samples fail, the sample batch shall be considered invalid, and the Owner may, at its sole discretion, terminate this contract as well as withhold payment for services already rendered.

c. Air Sampling and Analysis
1) Collect area air samples at various locations and various projects for personal exposure assessment as directed by the Owner.
2) Air samples shall be collected in accordance with ASTM E1553-93.
3) Prepare air samples for analysis in accordance with ASTM E33-94
4) Analyze air samples using FAAS or GFAAS.

5) All equipment required for personal air sampling, including pumps shall be provided by the Contractor at no extra cost to the Owner.
6) Provide results of air samples in micrograms per cubic meter.
7) A faxed summary of result must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected air sample. The sampling result must include for each air sample taken the Project, the building address, the sample number, the room or room equivalent, and the reading.
8) Turn-around time shall start after collection of the air samples, and includes travel time to and from the laboratory.
9) A detailed final report covering the results of all air samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each air sample, the Project, the building address, the sample number, the room or room equivalent, and the reading. The laboratory report contained in the final report must be signed by the Laboratory Director.
10) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
11) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"),or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
12) Air sampling technician shall be present during the entire shift of the air sampling.

d. TCLP Sampling and Analysis
1) Take core samples of construction waste as directed by the Owner and analyze by TCLP testing to determine if waste is hazardous.
2) Waste shall be classified as hazardous if the concentration of lead is greater than 5 parts per million by TCLP testing.
3) The laboratory used for the analysis of the TCLP samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
4) A faxed summary of result must be provided to the Owner within 48 hours after the Owner authorizes the Contractor to perform the TCLP analysis of the waste. Provide results in parts per million (ppm).
5) Final results provided to the Owner by the Contractor must include written sample preparation procedure and laboratory specific written procedures for performing TCLP, including quality control procedures used for performing the TCLP, and a table listing the sample numbers, description of the construction waste, and the result of the TCLP. The laboratory report contained in the final report must be signed by the Laboratory Director.
6) Final report must also specify detection limits.
7) Final report must be provided within 5 days from the time the authorization to perform the TCLP is given by the Owner.

General Provisions

20. Some of the work of this contract may be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
21. The Contractor shall take all necessary precautions to protect the property of the Owner, its residents, and the public. The Contractor must repair any damaged property, whether of the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgment of the Owner, match the existing materials and/or of equal quality and workmanship. All such repairs shall be at the Contractor's expense.
22. The Contractor shall develop a work plan to be performed as requested by the Department of Planning and Development. The detailed plan shall include coordination of the monitoring and sampling work with the Contractor in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
23. The Contractor shall perform work in accordance with the latest HUD Guidelines, except as such Guidelines are modified by the Owner in writing in this Contract, or any Contract pursuant to this Contract, and in accordance with all applicable Federal, State and Local regulations.
24. The Contractor shall include in the bid price all supplementary miscellaneous items not specified but implied or required in order to complete the work.

Submissions

25. Six (6) copies of the submissions listed below must be submitted to the Owner by the Contractor or Subcontractor performing the Work:
    a. Ability to perform lead dust wipe sampling by submitting evidence of the successful completion of lead inspector and/or risk assessor training by all staff to be assigned to the job including inspector technicians. As stated previously, training must be provided through an approved program.
    b. Laboratory certification by the State Department of Health (or other responsible agency) through its ELAP program and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided.
    c. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated in (2) above must also be provided for the subcontractor.

Waste Disposal

26. All waste generated must be legally disposed in accordance with the Federal, State and Local Regulations.

END OF SECTION 02 83 19 00b

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Task	Specification	Specification Description
02 83 19 00	02 83 00 00	Lead Remediation
02 83 19 13	02 83 00 00	Lead Remediation
02 83 19 13	02 83 19 00	Lead-Based Paint Remediation
02 83 19 13	02 83 19 00a	XRF Testing For Lead-Based Paint
02 83 19 13	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 83 33 00	02 83 00 00	Lead Remediation
02 83 33 13	02 83 00 00	Lead Remediation
02 83 33 13	02 83 19 00	Lead-Based Paint Remediation
02 83 33 13	02 83 19 00a	XRF Testing For Lead-Based Paint
02 83 33 13	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis

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SECTION 02 84 16 00 - HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBS AND MERCURY

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for removal of fluorescent light ballasts/capacitors and fluorescent light tubes. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Before Start of Work: Submit the following to the Owner's Representative for review. Do not start work until these submittals are returned with Owner's Representative's approval.
   a. Copy of State or local license for hazardous waste hauler;
   b. Certification of at least one on-site supervisor which has satisfactorily completed the OSHA 40 Hour Health and Safety Course for Handling Hazardous Materials;
   c. Certificates of workers which have successfully completed at least the OSHA 40-Hour Health and Safety Course for Hazardous Materials;
   d. List of employees scheduled to perform this work;
   e. Schedule of start and finish times and dates for this work;
   f. Name and address of landfill where these waste materials are to be deposited (include contact person and telephone numbers);
   g. Safety Data Sheets for all materials requiring removal;
   h. If contractor introduces any chemical into the work environmental, a SDS for that chemical is required before use;
   i. Transporter must have notified the EPA and/or the appropriate local government agency in advance of its intentions to transport PCB's, mercury and cadmium, and receive an identification number pursuant to the Toxic Substance Control Act (TSCA); and
   j. Contingency Plan for handling emergency spills or leaks.

1.2 PRODUCTS

A. Materials
1. Polyethylene Sheet: A single polyethylene film in the largest sheet size possible to minimize seams, 4.0 and 6.0 mil thick, clear, frosted, or black.
2. Duct Tape: Provide duct tape in 3" widths, witty an adhesive which is formulated to stick aggressively to sheet polyethylene.
3. Spray Cement: Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene.
4. Disposal Bays: Provide 6 mil thick leak-tight polyethylene bags.
5. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
6. **Drums:** Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA EPA (40 CFR Parts 264265 and 300), and DOT regulations (49 CFR Parts 171-178). Use of damaged drums will not be allowed.

1.3 EXECUTION

A. General
1. Where necessary, scaffolding shall be erected to fully access all applicable fluorescent light ballasts/capacitors and tubes. At no time will the ballasts/capacitors and tubes be allowed to drop onto the floor. Contractor must take care to protect from dropping the ballasts/capacitors and fluorescent tubes.
2. Prior to removing ballasts/capacitors and fluorescent tubes, contractor shall ensure that all electrical service to lights has been shut off, and locked out. Temporary lighting shall be erected to adequately illuminate work areas.
3. Depending on height of light fixtures, contractor shall utilize at least a 2-person per team system. The fluorescent light tubes shall be removed and passed to the appropriate number of workers required to lower the tubes to the floor without breaking them.
4. The worker on the floor shall lay the tubes in cardboard boxes large enough to hold a small quantity of tubes. Worker shall take care to not damage the tubes while they are lowered into the box. Once the box is full, it shall be wrapped with two layers of 6 mil thick polyethylene sheeting and sealed with duct tape.
5. Contractor may choose to either remove the fluorescent light ballasts/capacitors in-place or lower the lighting fixtures for easy access. The ballasts/capacitors shall be removed from the fixtures. Electrical wiring leading from the ballasts/capacitors shall be cut away. Ballasts/capacitors shall be placed in 55-gallon drums lined with at least two 6 mil thick polyethylene bags. Be careful not to overfill the drums so that they remain manageable. Once the drums have been filled to the acceptable level, seal the lid onto the top of the drum, and affix appropriate labels. Transport drums via hand dollies.

B. Worker Protection
1. As a minimum, while working with the ballasts/capacitors and light tubes, workers shall utilize impervious gloves adequate for the use with hazardous materials. If light ballasts/capacitors and/or light tubes are damaged, and/or exposure to these materials may reach the OSHA PEL or AGGIH threshold limit value (TLV), the contractor shall be required to provide impervious full body protection and respiratory protection. However, contractor is required to verify the type of protection required prior to working with these materials, and have written approval by Owner's Representative prior to beginning.
2. In addition, workers shall not smoke, drink or eat in these areas during work activities.

C. Storage Of Fluorescent Light Ballasts/Capacitors And Light Tubes
1. Once the containers holding the ballasts/capacitors and light tubes have been filled and sealed, they shall be stored in designated areas as agreed upon by the Owners Representative and Contractor. They shall not be allowed to be stored on-site in transportation vehicles until the time for them to be transported to the hazardous waste incinerators or landfill facility.

END OF SECTION 02 84 16 00

Task	Specification	Specification Description
02 86 00 00	02 41 19 00	Selective Demolition

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SECTION 02 87 13 00 - MOLD REMEDIATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the removal and disposal of mold. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. List of all personnel to be involved in the work with their training and certifications.
2. List of all products and procedures proposed for use in performance of the work.
3. Test reports.
4. Certificates.

C. References
1. U.S. EPA “Mold Remediation in Schools and Commercial Buildings”
2. U.S. EPA “A Brief Guide to Mold, Moisture, and Your Home”

D. Quality Assurance
1. Conform to all Federal, State, and Local regulations which govern the handling and disposal of mold materials.

1.2 PRODUCT - (Not Used)

1.3 EXECUTION

A. Environmental Assessment: The presence of mold, water damage, or musty odors shall be addressed immediately. In all instances, any source(s) of water must be stopped and the extent of water damaged determined. Water damaged materials shall be dried and repaired. Mold damaged materials shall be remediated in accordance with this document.
1. Visual Inspection: A visual inspection is the most important initial step in identifying a possible contamination problem. The extent of any water damage and mold growth shall be visually assessed. This assessment is important in determining remedial strategies. Ventilation systems shall also be visually checked, particularly for damp filters but also for damp conditions elsewhere in the system and overall cleanliness. Ceiling tiles, gypsum wallboard (sheetrock), cardboard, paper, and other cellulosic surfaces shall be given careful attention during a visual inspection. The use of equipment such as a boroscope, to view spaces in ductwork or behind walls, or a moisture meter, to detect moisture in building materials, may be helpful in identifying hidden sources of fungal growth and the extent of water damage.
2. Bulk/Surface Sampling
a. Bulk or surface sampling is not required to undertake a remediation. Remediation of visually identified fungal contamination shall proceed without further evaluation.
b. Bulk or surface samples may need to be collected to identify specific fungal contaminants as part of a medical evaluation if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is equivocal (e.g., discoloration, and staining).
c. An individual trained in appropriate sampling methodology shall perform bulk or surface sampling. Bulk samples shall be collected from visibly moldy surfaces by scraping or cutting materials with a clean tool into a clean plastic bag. Surface samples shall be collected by wiping a measured area with a sterile swab or by stripping the suspect surface

with clear tape. Surface sampling is less destructive than bulk sampling. Other sampling methods may also be available. A laboratory specializing in mycology shall be consulted for specific sampling and delivery instructions.

3. Air Monitoring
   a. Air sampling for fungi shall not be part of a routine assessment. This is because decisions about appropriate remediation strategies can usually be made on the basis of a visual inspection. In addition, air-sampling methods for some fungi are prone to false negative results and therefore cannot be used to definitively rule out contamination.
   b. Air monitoring may be necessary if an individual(s) has been diagnosed with a disease that is or may be associated with a fungal exposure (e.g., pulmonary hemorrhage/hemosiderosis, and aspergillosis).
   c. Air monitoring may be necessary if there is evidence from a visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building. It is preferable to conduct sampling while ventilation systems are operating.
   d. Air monitoring may be necessary if the presence of mold is suspected (e.g., musty odors) but cannot be identified by a visual inspection or bulk sampling (e.g., mold growth behind walls). The purpose of such air monitoring is to determine the location and/or extent of contamination.
   e. If air monitoring is performed, for comparative purposes, outdoor air samples shall be collected concurrently at an air intake, if possible, and at a location representative of outdoor air. For additional information on air sampling, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."
   f. Personnel conducting the sampling shall be trained in proper air sampling methods for microbial contaminants. A laboratory specializing in mycology shall be consulted for specific sampling and shipping instructions.
4. Analysis of Environmental Samples
   a. Microscopic identification of the spores/colonies requires considerable expertise. These services are not routinely available from commercial laboratories. Documented quality control in the laboratories used for analysis of the bulk/surface and air samples is necessary. The American Industrial Hygiene Association (AIHA) offers accreditation to microbial laboratories (Environmental Microbiology Laboratory Accreditation Program (EMLAP)). Accredited laboratories must participate in quarterly proficiency testing (Environmental Microbiology Proficiency Analytical Testing Program (EMPAT)).
5. Evaluation of bulk/surface and air sampling data shall be performed by an experienced health professional. The presence of few or trace amounts of fungal spores in bulk/surface sampling shall be considered background. Amounts greater than this or the presence of fungal fragments (e.g., hyphae, and conidiophores) may suggest fungal colonization, growth, and/or accumulation at or near the sampled location. Air samples shall be evaluated by means of comparison (i.e., indoors to outdoors) and by fungal type (e.g., genera, and species). In general, the levels and types of fungi found should be similar indoors (in non-problem buildings) as compared to the outdoor air. Differences in the levels or types of fungi found in air samples may indicate that moisture sources and resultant fungal growth may be problematic.

B. Remediation
1. General
   a. **In all situations, the underlying cause of water accumulation must be rectified or fungal growth will recur.** Any initial water infiltration shall be stopped and cleaned immediately. An immediate response (within 24 to 48 hours) and thorough clean up, drying, and/or removal of water damaged materials will prevent or limit mold growth. If the source of water is elevated humidity, relative humidity shall be maintained at levels below 60% to inhibit mold growth. Emphasis shall be on ensuring proper repairs of the building infrastructure, so that water damage and moisture buildup does not recur.
   b. Five different levels of abatement are described below. The size of the area impacted by fungal contamination primarily determines the type of remediation. The sizing levels below

are based on professional judgment and practicality; currently there is not adequate data to relate the extent of contamination to frequency or severity of health effects. **The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.** The listed remediation methods were designed to achieve this goal, however, due to the general nature of these methods it is the responsibility of the people conducting remediation to ensure the methods enacted are adequate. The listed remediation methods are not meant to exclude other similarly effective methods. Any changes to the remediation methods listed in these guidelines, however, shall be carefully considered prior to implementation.

c. Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are structurally sound and are visibly moldy can be cleaned and reused. Cleaning shall be done using a detergent solution. Porous materials such as ceiling tiles and insulation, and wallboards with more than a small area of contamination shall be removed and discarded. Porous materials (e.g., wallboard, and fabrics) that can be cleaned, can be reused, but should be discarded if possible. A professional restoration consultant shall be contacted when restoring porous materials with more than a small area of fungal contamination. All materials to be reused shall be dry and visibly free from mold. Routine inspections shall be conducted to confirm the effectiveness of remediation work.

d. The use of gaseous, vapor-phase, or aerosolized biocides for remedial purposes is **not** recommended. The use of biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space if used improperly. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mold. For additional information on the use of biocides for remedial purposes, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."

2. ***Level I***: **Small Isolated Areas** (10 sq. ft or less) - e.g., ceiling tiles, small areas on walls

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons recovering from recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).

d. Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.

e. Contaminated materials that cannot be cleaned shall be removed from the building in a sealed plastic bag. There are no special requirements for the disposal of moldy materials.

f. The work area and areas used by remedial workers for egress shall be cleaned with a damp cloth and/or mop and a detergent solution.

g. All areas shall be left dry and visibly free from contamination and debris.

3. ***Level II***: **Mid-Sized Isolated Areas** (10 - 30 sq. ft.) - e.g., individual wallboard panels.

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
d. The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
e. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
f. Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
g. The work area and areas used by remedial workers for egress shall be HEPA vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) and cleaned with a damp cloth and/or mop and a detergent solution.
h. All areas shall be left dry and visibly free from contamination and debris.

4. ***Level III*: Large Isolated Areas** (30 - 100 square feet) - e.g., several wallboard panels.
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project.
   b. The following procedures *at a minimum* are recommended:
      1) Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      2) The work area and areas directly adjacent shall be covered with a plastic sheet(s) and taped before remediation, to contain dust/debris.
      3) Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
      4) The work area and areas directly adjacent shall be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and surrounding areas shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
   c. If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level IV are followed.

5. ***Level IV*: Extensive Contamination** (greater than 100 contiguous square feet in an area)
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Full-face respirators with high efficiency particulate air (HEPA) cartridges
         b) Disposable protective clothing covering both head and shoes
         c) Gloves
      2) Containment of the affected area:

a) Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
b) The use of an exhaust fan with a HEPA filter to generate negative pressurization
c) Airlocks and decontamination room

3) Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
4) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. The outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop with a detergent solution and be visibly clean prior to the removal of isolation barriers.
6) Air monitoring shall be conducted prior to occupancy to determine if the area is fit to reoccupy.

6. ***Level V***: Remediation of HVAC Systems
   a. A Small Isolated Area of Contamination (<10 square feet) in the HVAC System
      1) Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
      2) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      3) The HVAC system shall be shut down prior to any remedial activities.
      4) The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned shall be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and areas immediately surrounding the work area shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
      9) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.
   b. Areas of Contamination (>10 square feet) in the HVAC System: A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended.
         b) Gloves and eye protection

c) Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes shall be worn if contamination is greater than 30 square feet.

2) The HVAC system shall be shut down prior to any remedial activities.

3) Containment of the affected area:
   a) Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.
   b) The use of an exhaust fan with a HEPA filter to generate negative pressurization.
   c) Airlocks and decontamination room if contamination is greater than 30 square feet.

4) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.

5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.

6) All areas shall be left dry and visibly free from contamination and debris.

7) Air monitoring shall be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.

8) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.

7. Hazard Communication: When fungal growth requiring large-scale remediation is found, the building owner, management, and/or employer shall notify occupants in the affected area(s) of its presence. Notification shall include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to bioaerosol exposure should see their physicians for a referral to practitioners who are trained in occupational/environmental medicine or related specialties and are knowledgeable about these types of exposures. Individuals seeking medical attention shall be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

END OF SECTION 02 87 13 00

Task	Specification	Specification Description
02 87 13 33	02 87 13 00	Mold Remediation

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SECTION 02 87 16 13 - BIRD EXCREMENT REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for bird-excrement removal.

B. Related Requirements:

1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
2. Section 024296 "Historic Removal and Dismantling" for special requirements related to removing items from historic surfaces.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 PRECONSTRUCTION MEETINGS

A. Preconstruction Conference: Conduct conference at [**Project site**].

1. Review minutes of Preliminary Historic Treatment Conference that pertain to protection of historic areas and surfaces.
2. Review methods and procedures related to excrement removal, including, but not limited to, the following:

a. Bird-excrement-removal specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Fire-protection plan.
d. Coordination with building occupants.
e. Dust and HVAC control.

1.5 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Preconstruction Test Reports: For removal materials and methods.

B. Qualification Statements: For [**bird-excrement-removal specialist**][**and**][**industrial hygienist**].

1.6 QUALITY ASSURANCE

A. Bird-Excrement-Removal Specialist Qualifications: A firm that employs personnel experienced and skilled in the processes and operations indicated.

B. Industrial Hygienist Qualifications: Certified as Industrial Hygienist by the American Board of Industrial Hygiene; having Bachelor's degree in industrial hygiene, public health, biological science, occupational health, or environmental and safety discipline; and experienced in work of types specified.

C. Regulatory Requirements: Comply with notification regulations of authorities having jurisdiction before beginning excrement-removal work. Comply with collection and disposal regulations of authorities having jurisdiction.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified bird-excrement-removal specialist to perform preconstruction testing on surfaces with accumulations of bird excrement.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

B. Preconstruction Testing: Performed by a qualified bird-excrement-removal specialist to demonstrate effects of removal work on substrate appearance and longevity and set quality standards for materials and execution.

1. Bird-Excrement Removal: Remove excrement from an area [**approximately 25 sq. ft.**][**as indicated**] for each type of [**cornice**][**coping**][**floor**][**and**][**wall**] substrate material.

a. Test chemicals and methods on samples of adjacent building materials for possible adverse reactions. Do not use chemicals and methods known to have deleterious effect.
b. Allow a waiting period of not less than seven days after completion of removal work to permit a study of test area for deleterious effects.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Select materials and methods of use based on the following, subject to preconstruction testing:

1. Previous effectiveness in performing the work involved.
2. Minimal possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
b. Leave residue on surfaces.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with temporary barrier and air quality control requirements in Section 015000 "Temporary Facilities and Controls."

B. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from excrement-removal procedures.

1. Use only proven protection methods, appropriate to each area and surface being protected.
2. Provide barricades, dustproof partitions, and temporary directional signage to exclude public from work areas.
3. Contain dust and debris generated by excrement-removal work and prevent it from reaching the public or adjacent surfaces.

C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.

3.2 BIRD-EXCREMENT REMOVAL

A. General: [**The Owner will engage**][**Engage**] a qualified industrial hygienist to perform tests, make recommendations, and observe the Work. Follow procedures required by authorities having jurisdiction and recommended by industrial hygienist.

B. Removing Bird Excrement: Have bird-excrement-removal Work performed by a qualified bird-excrement-removal specialist.[**Remove exterior bird-excrement accumulations with building windows and other openings in the building closed or sealed off.**][**Remove interior bird excrement with other parts of the building sealed off from work area and with windows and other openings to exterior areas accessible to the public closed or sealed off.**]

1. Use materials and follow procedures as determined by preconstruction testing.
2. Before removal, treat bird excrement to kill pathogens; dampen excrement to prevent particles becoming airborne.
3. Use only nonmetallic tools, such as plastic spatulas and brushes with natural fiber or nylon bristles.
4. Collect excrement as it is removed, seal it in durable plastic bags, and legally dispose of it off-site.
5. Repeat removal procedure above where required to produce cleaning effect established by preconstruction testing.

C. Removing Bird-Excrement Stain: Clean as required in Section pertaining to cleaning substrate material from which bird excrement was removed.

END OF SECTION 02 87 16 13

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Task	Specification	Specification Description
02 89 00 00	01 11 19 00	No Specification Required
02 89 00 00	02 83 00 00	Lead Remediation
02 89 00 00	02 83 19 00	Lead-Based Paint Remediation
02 89 00 00	02 83 19 00a	XRF Testing For Lead-Based Paint
02 89 00 00	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 90 55 00	01 11 19 00	No Specification Required

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SECTION 03 01 30 00 - MAINTENANCE OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bonding agents.
2. Patching mortar.
3. Preplaced concrete materials.
4. Joint filler.
5. Epoxy crack-injection materials.
6. Corrosion-inhibiting materials.
7. Polymer-overlay materials.
8. Polymer-sealer materials.
9. Composite reinforcement materials.

1.2 ALLOWANCES

A. Allowances for maintenance of cast-in-place concrete are specified in Section 012100 "Allowances."

B. Field quality-control testing is part of testing and inspecting allowance.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1. Unit prices apply to authorized work covered by [**quantity allowances**][**estimated quantities**].
2. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.

B. General: Unit prices include the cost of preparing existing construction to receive the Work indicated[**and costs of field quality control required for units of Work completed**].

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to concrete work, including, but not limited to, the following:

a. Verify concrete-maintenance specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Concrete restoration specialist.
c. Materials, material application, sequencing, tolerances, and required clearances.
d. Shoring and bracing.
e. Quality-control program.
f. Coordination with building occupants.

1.5 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, chemical composition, physical properties, test data, and mixing, preparation, project application types consisting of horizontal, vertical or overhead locations and application instructions.

B. Shop Drawings:

1. Shoring and Bracing: Provide Drawings or documentation to ensure that structure and temporary supports withstand the anticipated loads during construction and the effect of demolition on the capacity of the structure. Submit design calculations, sealed by an engineer licensed in state of Project, for shoring and bracing where required by the extent of structural repairs or removal of deteriorated concrete and subsequent replacement.

C. Samples: Cured Samples for each exposed product and for each color and texture specified, [**in manufacturer's standard size appropriate for each type of work**].

D. Samples for Initial Selection: Cured Samples for each exposed product and for each color and texture.

1. Include sets of patching-material Samples in the form of briquettes, at least [**3 inches (75 mm) long by 1-1/2 inches (38 mm) wide**] representative of the range of concrete colors on the building. Document each Sample with product, mix, and/or other information necessary to replicate it.
2. Include sets of Samples for epoxy crack-injection adhesive and capping adhesive in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.
3. Include sets of polymer-overlay Samples in the form of treated cementitious tiles at least [**4 inches (100 mm) long by 4 inches (100 mm) wide**] representative of the range of required colors and textures.
4. Include sets of polymer-sealer Samples in the form of treated cementitious tiles at least [**4 inches (100 mm) long by 4 inches (100 mm) wide**] representative of the range of required colors and textures.
5. Have each set of Samples contain a close color range of at least [**three**][**six**] Samples of different mixes of materials that match the variations in existing, adjacent concrete when cured and dry.

E. Samples for Verification: Cured Samples for each exposed product and for each color and texture specified.

1. Include Samples of each required type, color, and texture of patching material in the form of patches in drilled holes or sawed joints in sample concrete representative of the range of concrete colors on the building.
2. Include Samples of epoxy crack-injection adhesive in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.
3. Include Samples of each required type, color, and texture of polymer-overlay material in the form of cementitious tiles at least [**8 inches (200 mm) long by 8 inches (200 mm) wide**].
4. Include Samples of each required type, color, and texture of polymer-sealer material in the form of cementitious tiles at least [**8 inches (200 mm) long by 8 inches (200 mm) wide**].

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**concrete-maintenance specialist**][**and**][**manufacturers**].

B. Material Certificates: For each type of [**portland cement**][**aggregate**] supplied for mixing or adding to products at Project site.

C. Product Test Reports: For each [**manufactured bonding agent**][**cementitious patching mortar**][**joint filler**][**crack-injection adhesive**][**polymer overlay**][**polymer sealer**][**and**][**composite structural reinforcement**], for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

E. Quality-Control Program: Submit before work begins.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Each [**manufactured bonding-agent**][**packaged patching-mortar**][**joint-filler**][**crack-injection-adhesive**][**corrosion-inhibiting-treatment**][**polymer-overlay**][**polymer-sealer**][**and**][**composite-structural-reinforcement**] manufacturer must employ factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.

B. Concrete-Maintenance Specialist Qualifications: Engage an experienced concrete-maintenance firm that employs installers and supervisors who are trained and approved by manufacturer to apply [**packaged patching-mortar**][**crack-injection adhesive**][**corrosion-inhibiting treatments**][**polymer overlays**][**polymer sealers**][**and**][**composite structural reinforcement**] when performing the Work of this Section. Firm must have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing or patching new concrete is insufficient experience for concrete-maintenance work.

1. Field Supervision: Concrete-maintenance specialist firm must maintain experienced full-time supervisors on Project site during times that concrete-maintenance work is in progress.

C. Quality-Control Program: Prepare a written plan for concrete maintenance to systematically demonstrate the ability of personnel to properly perform maintenance work, including each phase or process, protection of surrounding materials during operations, and control of debris and runoff during the Work. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.

D. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1.8 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Concrete Removal and Patching Mockup: Remove and repair an [**approximately 50 sq. ft. (4.6 sq. m)**][**approximately 100 sq. in. (645 sq. cm)**] area of [**deteriorated concrete deck**][**deteriorated concrete wall**].
2. Floor Joint Repair Mockup: Cut out and reinstall joints in two separate areas [**, each approximately 48 inches (1200 mm) long**][**as indicated on Drawings**].
3. Epoxy Crack Injection Mockup: Perform epoxy crack-injection material in two separate areas [**,**

each approximately 48 inches (1200 mm) long][as indicated on Drawings].

4. Polymer-Overlay Mockup: Apply an [**approximately 50 sq. ft. (4.6 sq. m)**] area of polymer overlay.
5. Polymer Sealer Mockup: Apply an [**approximately 50 sq. ft. (4.6 sq. m)**] area of polymer sealer.
6. Composite Structural-Reinforcement Mockup: Apply composite structural reinforcement [**a minimum of 48 inches (1200 mm) long][as indicated on Drawings**].
7. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
8. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.

B. Store cementitious materials off the ground, under cover, and in a dry location.

C. Store aggregates covered and in a dry location; maintain grading and other required characteristics and prevent contamination.

1.10 FIELD CONDITIONS

A. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

1. Use only Class A epoxies when substrate temperatures are below or are expected to go below **40 deg F (5 deg C)** within eight hours.
2. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below **60 deg F (16 deg C)** within eight hours.
3. Use only Class C epoxies when substrate temperatures are above and are expected to stay above **60 deg F (16 deg C)** for eight hours.

B. Cold-Weather Requirements for Cementitious Materials:

1. Do not apply unless concrete surface and air temperatures are above **40 deg F (5 deg C)** and will remain so for at least 48 hours after completion of Work.
2. Comply with the following procedures:

    a. When air temperature is below **40 deg F (5 deg C)**, heat patching-material ingredients and existing concrete to produce temperatures between **40 and 90 deg F (5 and 32 deg C)**.
    b. When mean daily air temperature is between **25 and 40 deg F (minus 4 and plus 5 deg C)**, cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above **32 deg F (0 deg C)** within the enclosure for 48 hours after repair.
    c. When mean daily air temperature is below **25 deg F (minus 4 deg C)**, provide enclosure and heat to maintain temperatures above **32 deg F (0 deg C)** within the enclosure for 48 hours after repair.

C. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial

shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of **90 deg F (32 deg C)** and above.

D. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below **55 deg F (13 deg C)** or above [**75 deg F (24 deg C)**][**90 deg F (32 deg C)**]. Apply only to [**dry substrates**][**substrates that have been dry for at least 72 hours**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

2.2 BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Manufactured product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARDEX Americas**]
    b. [**Dayton Superior Corporation**]
    c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    d. [**Kaufman Products, Inc**]
    e. [**MAPEI Corporation**]
    f. [**Master Builders Solutions**]
    g. [**Sika Corporation**]
    h. [**SpecChem, LLC**]
    i. [**Sto Corp.**]

B. Epoxy Bonding Agent: ASTM C881/C881M [**Type II**][**Type V**] bonding system, free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Abatron, Inc**]
    b. [**ChemCo Systems, Inc.**]
    c. [**Dayton Superior Corporation**]
    d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    e. [**Kaufman Products, Inc**]
    f. [**MAPEI Corporation**]
    g. [**Master Builders Solutions**]
    h. [**Sika Corporation**]

i. [**Sto Corp.**]
j. [**US SPEC, Division of US MIX Company**]
k. [**Xypex Chemical Corporation**]

C. Latex Bonding Agent, Redispersible: Type I, ASTM C1059/C1059M[**for use at nonstructural and interior locations unless otherwise indicated**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dayton Superior Corporation**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Kaufman Products, Inc**]
d. [**US SPEC, Division of US MIX Company**]
e. [**W. R. Meadows, Inc**]

D. Latex Bonding Agent, Nonredispersible: Type II, ASTM C1059/C1059M[**for use at structural and exterior locations and where indicated**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**MAPEI Corporation**]
f. [**US SPEC, Division of US MIX Company**]
g. [**W. R. Meadows, Inc**]

E. Mortar Scrub Coat: Mix consisting of 1 part portland cement and 1 part fine aggregate complying with ASTM C144, except 100 percent passing a **No. 16 (1.18-mm)** sieve.

2.3 PATCHING MORTAR

A. Patching Mortar Requirements:

1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
2. Color and Aggregate Texture: Provide patching mortar and aggregates of colors and sizes necessary to produce patching mortar[**where indicated**] that matches existing, adjacent, and exposed concrete. Blend several aggregates if necessary to achieve suitable matches.
3. Coarse Aggregate for Patching Mortar: ASTM C33/C33M, Size No. 8, Class 5S washed aggregate. Add to patching-mortar mix only as permitted by patching-mortar manufacturer.

B. Job-Mixed Patching Mortar : 1 part portland cement and 2-1/2 parts fine aggregate complying with ASTM C144, except 100 percent passing a **No. 16 (1.18-mm)** sieve.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CGM, Incorporated**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**KOSTER American Corporation**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Sika Corporation**]
j. [**Simpson Strong-Tie Co., Inc.**]
k. [**Sto Corp.**]
l. [**Tnemec Company, Inc.**]
m. [**US SPEC, Division of US MIX Company**]
n. [**W. R. Meadows, Inc**]

C. Cementitious Patching Mortar : Packaged, dry mix for repair of concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CGM, Incorporated**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**KOSTER American Corporation**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Schonox HPS North America, Inc.**]
j. [**Sika Corporation**]
k. [**Simpson Strong-Tie Co., Inc.**]
l. [**Sto Corp.**]
m. [**Tnemec Company, Inc.**]
n. [**United Gilsonite Laboratories (UGL)**]
o. [**US SPEC, Division of US MIX Company**]
p. [**W. R. Meadows, Inc**]
q. [**Xypex Chemical Corporation**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

D. Rapid-Strengthening, Cementitious Patching Mortar : [**ASTM C928/C928M**] packaged, dry mix for repair of concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARDEX Americas**]
    b. [**CGM, Incorporated**]
    c. [**ChemMasters, Inc**]
    d. [**Dayton Superior Corporation**]
    e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    f. [**Kaufman Products, Inc**]
    g. [**MAPEI Corporation**]
    h. [**Master Builders Solutions**]
    i. [**Schonox HPS North America, Inc.**]
    j. [**Sika Corporation**]
    k. [**Simpson Strong-Tie Co., Inc.**]
    l. [**Sto Corp.**]
    m. [**US SPEC, Division of US MIX Company**]
    n. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**1000 psi (7.0 MPa)**][**2000 psi (13.8 MPa)**][**3000 psi (21.0 MPa)**][**4000 psi (27.6 MPa)**] within [**three**] hours when tested in accordance with ASTM C109/C109M.

E. Polymer-Modified, Cementitious Patching Mortar : Packaged, dry mix for repair of concrete and that contains a[**nonredispersible**] latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AQUAFIN, Inc**]
    b. [**ARDEX Americas**]
    c. [**CGM, Incorporated**]
    d. [**ChemMasters, Inc**]
    e. [**Cortec Corporation**]
    f. [**Dayton Superior Corporation**]
    g. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    h. [**Kaufman Products, Inc**]
    i. [**MAPEI Corporation**]
    j. [**Master Builders Solutions**]
    k. [**Schonox HPS North America, Inc.**]
    l. [**Sika Corporation**]
    m. [**Simpson Strong-Tie Co., Inc.**]
    n. [**Sto Corp.**]
    o. [**United Gilsonite Laboratories (UGL)**]
    p. [**US SPEC, Division of US MIX Company**]
    q. [**Uzin Utz North America, Inc.**]
    r. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

F. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar : Packaged, dry mix for repair of concrete and that contains silica fume complying with ASTM C1240 and a[**nonredispersible**] latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AQUAFIN, Inc**]
b. [**CGM, Incorporated**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]
g. [**Simpson Strong-Tie Co., Inc.**]
h. [**Sto Corp.**]
i. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

2.4 PREPLACED CONCRETE MATERIALS

A. Preplaced Aggregate: Washed aggregate, ASTM C33/C33M, Class 5S, with [**95 to 100 percent passing a 1-1/2-inch (38-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, zero to 10 percent passing a 1/2-inch (12.7-mm) sieve, and zero to 2 percent passing a 3/8-inch (9.5-mm) sieve**][**100 percent passing a 1-1/2-inch (38-mm) sieve, 95 to 100 percent passing a 1-inch (25-mm) sieve, 40 to 80 percent passing a 3/4-inch (19-mm) sieve, zero to 15 percent passing a 1/2-inch (12.7-mm) sieve, and zero to 2 percent passing a 3/8-inch (9.5-mm) sieve**].

B. Fine Aggregate for Grout: Fine aggregate in accordance with ASTM C33/C33M, but with 100 percent passing a **No. 8 (2.36-mm)** sieve, 95 to 100 percent passing a **No. 16 (1.18-mm)** sieve, 55 to 80 percent passing a **No. 30 (0.6-mm)** sieve, 30 to 55 percent passing a **No. 50 (0.3-mm)** sieve, 10 to 30 percent passing a **No. 100 (0.15-mm)** sieve, zero to 10 percent passing a **No. 200 (0.075-mm)** sieve, and having a fineness modulus of 1.30 to 2.10.

C. Grout Fluidifier for Grout: ASTM C937.

D. Pozzolans for Grout: ASTM C618.

2.5 JOINT FILLER

A. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A durometer hardness of at least 80 in accordance with ASTM D2240.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**SIMIRON Inc.**]
b. [**Abatron, Inc**]
c. [**ChemCo Systems, Inc.**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Metzger/McGuire**]
j. [**Sika Corporation**]

B. Polyurea Joint Filler: Two-component, semirigid, 100 percent solids, polyurea resin with a Shore A durometer hardness of at least 80 in accordance with ASTM D2240.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SIMIRON Inc.**]
b. [**ARDEX Americas**]
c. [**ASTC Global, Inc.**]
d. [**ChemCo Systems, Inc.**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**HTS Chemical; Hi-Tech Systems**]
g. [**Kaufman Products, Inc**]
h. [**Master Builders Solutions**]
i. [**Metzger/McGuire**]
j. [**SpecChem, LLC**]
k. [**US SPEC, Division of US MIX Company**]

C. Color: [**As indicated by manufacturer's designations**][**Matching existing joint filler**][**As selected by Architect from full range of industry colors**].

2.6 EPOXY CRACK-INJECTION MATERIALS

A. Epoxy Crack-Injection Adhesive: ASTM C881/C881M, bonding system [**Type I,**][**Type IV,**][**Type IV at structural locations and where indicated, Type I at other locations;**] free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Abatron, Inc**]
b. [**ChemCo Systems, Inc.**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]

e. [**Fyfe Co. LLC**]
f. [**Kaufman Products, Inc**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Sika Corporation**]
j. [**Sto Corp.**]
k. [**US SPEC, Division of US MIX Company**]
l. [**W. R. Meadows, Inc**]

2. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.
3. Color: Provide epoxy crack-injection adhesive and capping adhesive [**as indicated by manufacturer's designations**][**that blend with existing, adjacent concrete and do not stain concrete surface**][**As selected by Architect from full range of industry colors**].

2.7 CORROSION-INHIBITING MATERIALS

A. Corrosion-Inhibiting Treatment: Waterborne solution of alkaline corrosion-inhibiting chemicals for concrete-surface application that penetrates concrete by diffusion and forms a protective film on steel reinforcement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Cortec Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

2.8 POLYMER-OVERLAY MATERIALS

A. Polymer Overlay: Epoxy adhesive complying with ASTM C881/C881M, bonding system Type III, with surface-applied aggregate for skid resistance; free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemCo Systems, Inc.**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**MAPEI Corporation**]
f. [**Master Builders Solutions**]
g. [**Sika Corporation**]
h. [**Sto Corp.**]

i. [**US SPEC, Division of US MIX Company**]

2. Aggregate: ACI 503.3, oven-dried, washed silica sand.
3. Color and Texture: [**As indicated by manufacturer's designations**][**Matching existing**][**As selected by Architect from full range of industry colors**].

2.9 POLYMER-SEALER MATERIALS

A. Epoxy Polymer Sealer: Low-viscosity epoxy, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; [**free of VOCs**][**VOC content 100 g/L or less**][**VOC content 400 g/L or less**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemCo Systems, Inc.**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

2. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from full range of industry colors**].

B. Methacrylate Polymer Sealer: Low-viscosity, high-molecular-weight methacrylate, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; [**free of VOCs**][**VOC content 100 g/L or less**][**VOC content 400 g/L or less**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SIMIRON Inc.**]
b. [**Kwik Bond Polymers**]
c. [**Master Builders Solutions**]
d. [**Sika Corporation**]
e. [**Transpo Industries, Inc.**]

2. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from full range of industry colors**].

2.10 COMPOSITE REINFORCEMENT MATERIALS

A. Composite Structural Reinforcement: Manufacturer's system consisting of [**carbon-fiber**][**or**][**glass-fiber**] reinforcement in the form of [**tow sheet with field-applied saturant**][**or**][**preimpregnated sheet**]

and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as externally bonded structural reinforcement for concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Fyfe Co. LLC**]
    b. [**MAPEI Corporation**]
    c. [**Master Builders Solutions**]
    d. [**Schonox HPS North America, Inc.**]
    e. [**Sika Corporation**]

2.11 MISCELLANEOUS MATERIALS

A. Curing Materials: For ready-mixed concrete or packaged repair materials.

B. Formwork Materials: Form-facing materials must comply with **ACI 301 (ACI 301M)** requirements.

C. Water: Potable.

D. Cleaning Agent: Commercial muriatic acid solution.

2.12 MIXES

A. General: Mix products, in clean containers, in accordance with manufacturer's written instructions.

1. Do not add water, thinners, or additives unless recommended by manufacturer.
2. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
3. Do not mix more materials than can be used within time limits recommended by manufacturer. Discard materials that have begun to set.

B. Mortar Scrub Coat: Mix dry ingredients with enough water to provide consistency of thick cream.

C. Dry-Pack Mortar: Mix required type(s) of patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

D. Concrete Materials: Comply with [**Section 033000 "Cast-in-Place Concrete."**][**Section 033300 "Architectural Concrete."**]

E. Concrete Mixture Materials: Ready mixed.

1. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless modified by requirements in the Contract Documents.
2. Portland Cement: ASTM C150/C150M, Type I, II, or III unless otherwise indicated.
3. Fly Ash: ASTM C618, Class C or F.
4. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
5. Silica Fume: ASTM C1240 amorphous silica.

6. Aggregates: ASTM C330/C330M, nominal maximum aggregate size, gradation and types appropriate for the dimension of the repair area and project application.
7. Air-Entraining Admixture: ASTM C260/C260M.
8. Chemical Admixtures: Certified and as recommended by manufacturer for project applications to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

F. Repair Underlayment:

1. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/8 inch** and that can be feathered at edges to match adjacent floor elevations.
2. Compressive Strength: Not less than [**4100 psi (29 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

G. Repair Overlayment:

1. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/4 inch (6 mm)** and that can be filled in over a scarified surface to match adjacent floor elevations.
2. Compressive Strength: Not less than [**5000 psi (34.5 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

H. Grout for Use with Preplaced Aggregate: Proportion in accordance with ASTM C938. Add grout fluidifier to mixing water followed by portland cement, pozzolan, and fine aggregate.

PART 3 - EXECUTION

3.1 CONCRETE MAINTENANCE

A. Have concrete-maintenance work performed only by qualified concrete-maintenance specialist.

B. Comply with manufacturers' written instructions for surface preparation and product application.

3.2 EXAMINATION

A. Notify Architect seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.

B. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls, make boundaries level and plumb unless otherwise indicated.

C. Pachometer Testing: Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

D. Perform surveys as the Work progresses to detect hazards resulting from concrete-maintenance work.

3.3 PREPARATION

A. Ensure that supervisory personnel are on-site and on duty when concrete-maintenance work begins and during its progress.

B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, plants, and surrounding buildings from harm resulting from concrete-maintenance work.

1. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
2. Use only proven protection methods appropriate to each area and surface being protected.
3. Provide temporary barricades, barriers, and directional signage to exclude public from areas where concrete-maintenance work is being performed.
4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of concrete-maintenance work.
5. Contain dust and debris generated by concrete-maintenance work and prevent it from reaching the public or adjacent surfaces.
6. Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment that ensure that such water will not create a hazard or adversely affect other building areas or materials.
7. Protect floors and other surfaces along haul routes from damage, wear, and staining.
8. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.
9. Protect adjacent surfaces and equipment by covering them with heavy polyethylene film and waterproof masking tape[**or a liquid-strippable masking agent**]. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
10. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
11. Dispose of debris and runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Existing Drains: Prior to the start of concrete-maintenance work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin concrete-maintenance work in an area until the drainage system is in working order.

1. Prevent solids, such as aggregate or mortar residue, from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete-maintenance work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

D. Preparation for Concrete Removal: Examine construction to be repaired to determine best methods to safely and effectively perform concrete-maintenance work. Examine adjacent work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.

1. Verify that affected utilities have been disconnected and capped.
2. Inventory and record the condition of items to be removed for reinstallation or salvage.
3. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.

E. Reinforcing-Bar Preparation: Remove loose and flaking rust from exposed reinforcing bars by [**high-pressure water cleaning**][**abrasive blast cleaning**][**needle scaling**][**or**][**wire brushing**] until only

tightly adhered light rust remains.

1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, cut bars and remove and replace as indicated on Drawings.
2. Remove additional concrete as necessary to provide at least **3/4-inch (19-mm)** clearance at existing and replacement bars.
3. Splice replacement bars to existing bars in accordance with **ACI 318 (ACI 318M)** by lapping, welding, or using mechanical couplings.

F. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**] deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.

G. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete to remove dirt, oils, films, and other materials detrimental to treatment application.

1. Use [**low-pressure water cleaning**][**detergent scrubbing**][**or**][**sand blasting**].
2. Allow surface to dry before applying corrosion-inhibiting treatment.

H. Surface Preparation for Overlays:

1. Remove delaminated material and deteriorated concrete surface material.
2. Roughen surface of concrete to produce a surface profile matching CSP [**3**][**4**][**5**][**6**][**7**][**8**][**9**] in accordance with ICRI 310.2.
3. Use [**sand blasting**][**shot blasting**][**scarifying**][**needle scaling**][**high-pressure water jetting**][**scabbling**][**flame blasting**][**or**][**milling**].
4. Sweep and vacuum roughened surface to remove debris[**followed by low-pressure water cleaning**].

I. Acidic Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 in accordance with ICRI 310.2.[**Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.**]

1. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
2. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
3. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable in accordance with sealer manufacturer's written instructions.
4. When pH is acceptable in accordance with sealer manufacturer's written instructions and surface is clean, vacuum dry.

J. Nonacidic Surface Preparation for Sealers: Clean concrete to remove dirt, oils, films, and other materials detrimental to sealer application.

1. Use [**shot blasting**][**low-pressure water cleaning**][**or**][**detergent scrubbing**].

K. Surface Preparation for Composite Structural Reinforcement: Clean concrete where reinforcement and epoxy patching mortar is to be placed by [**low-pressure water cleaning**][**or**][**detergent scrubbing**] to remove dirt, oils, films, and other materials detrimental to epoxy patching mortar.

1. Roughen surface of concrete by sand blasting.
2. Remove delaminated material and deteriorated concrete surface material.
3. Sweep and vacuum roughened surface to remove debris[**followed by low-pressure water cleaning**].

3.4 REMOVAL OF CONCRETE

A. Do not overload structural elements with debris.

B. Saw-cut perimeter of areas indicated for removal to a depth of at least [1/2 inch (13 mm)]. Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.

C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.

D. Remove additional concrete if necessary to provide a depth of removal of at least [1/2 inch (13 mm)] over entire removal area.

E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least 3/4-inch (19-mm) clearance around bar.

F. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.

G. Provide surfaces with a fractured profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level unless otherwise directed.

H. Thoroughly clean removal areas of loose concrete, dust, and debris.

3.5 APPLICATION OF BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion System: Apply to reinforcing bars [**and concrete**]by stiff brush or hopper spray in accordance with manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.

B. Epoxy Bonding System: Apply to reinforcing bars[**and concrete**] by brush, roller, or spray in accordance with manufacturer's written instructions, leaving no pinholes or other uncoated areas.[**Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat.**] Place patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.

C. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.

D. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface in accordance with manufacturer's written instructions. Place patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.

E. Mortar Scrub Coat for Job-Mixed Patching Mortar and Concrete: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub coat dries, recoat before placing patching mortar or concrete.

F. Slurry Coat for Cementitious Patching Mortar: Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar[**mixed with latex bonding agent**] into substrate, filling pores and voids.

3.6 INSTALLATION OF PATCHING MORTAR

A. Place patching mortar as specified in this article unless otherwise recommended in writing by manufacturer[**or where dry-pack mortar is indicated**].

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified [**bonding agent**][**mortar scrub coat**][**slurry coat**][**bonding agent and slurry coat**].

C. General Placement: Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.

D. Vertical Patching: Place material in lifts of not more than [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (76 mm)**] or less than [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]. Do not feather edge.

E. Overhead Patching: Place material in lifts of not more than [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] or less than [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]. Do not feather edge.

F. Consolidation: After each lift is placed, consolidate material and screed surface.

G. Multiple Lifts: Where multiple lifts are used, score surface of lifts to provide a rough surface for placing subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.

H. Finishing: Allow surfaces of lifts that are to remain exposed to become firm and then finish to a [**smooth surface with a wood or sponge float**][**rough surface with a broom or burlap drag**][**surface matching adjacent concrete**].

I. Curing: Wet-cure cementitious patching materials, including polymer-modified cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.7 INSTALLATION OF DRY-PACK MORTAR

A. Use dry-pack mortar for deep cavities[**and where indicated**]. Place as specified in this article unless otherwise recommended in writing by manufacturer.

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified [**bonding agent**][**mortar scrub coat**][**slurry coat**][**bonding agent and slurry coat**].

C. Place dry-pack mortar into cavity by hand, and compact tightly into place. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.

D. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.

E. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.8 CONCRETE PLACEMENT

A. Place concrete in accordance with [**Section 033000 "Cast-in-Place Concrete"**][**Section 033300 "Architectural Concrete"**] and as specified in this article.

B. Epoxy-Modified Pretreatment: Apply [**epoxy-modified, cementitious bonding and anticorrosion agent**][**epoxy bonding agent**] to reinforcement[**and concrete substrate**].

C. Latex Pretreatment: Apply [**latex bonding agent**][**Type I latex bonding agent**][**mortar scrub coat**] to concrete substrate.

D. Standard Placement: Place concrete by form-and-pump method unless otherwise indicated.

1. Use vibrators to consolidate concrete as it is placed.
2. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.

E. Form-and-Pump Placement: Place concrete by form-and-pump method where indicated.

1. Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and where forms abut existing concrete.
2. Pump concrete into place from bottom to top, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to **14 psi (96 kPa)**.

F. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

G. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.

3.9 GROUTING PREPLACED AGGREGATE CONCRETE

A. Use grouted preplaced aggregate concrete [**where indicated**][**for column and wall repairs**]. Place as specified in this article.

B. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and where forms abut existing concrete.

C. Apply [**epoxy-modified cementitious bonding and anticorrosion agent**][**epoxy bonding agent**] to reinforcement[**and concrete substrate**].

D. Place aggregate in forms, consolidating aggregate in lifts as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.

E. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.

F. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to **14 psi (96 kPa)**.

G. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

H. Repair voids with patching mortar and finish to match surrounding concrete.

3.10 FLOOR-JOINT REPAIR

A. Cut out deteriorated concrete [**and reconstruct sides of joint with patching mortar**] as indicated on Drawings. Install joint filler in nonmoving floor joints where indicated and as specified in this article.

B. Depth: Install joint filler to a depth of at least [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**]. Use fine silica sand no more than **1/4 inch (6 mm)** deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.

C. Top Surface: Install joint filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.

3.11 APPLICATION OF EPOXY CRACK-INJECTION MATERIALS

A. Clean cracks with oil-free compressed air or low-pressure water to remove loose particles.

B. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond.

C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.

D. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least **1/4 inch (6 mm)** thick by **1 inch (25 mm)** wider than crack.

E. Inject cracks wider than **0.003 inch (0.075 mm)** to a depth of **8 inches (200 mm)**.

F. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.

G. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

3.12 APPLICATION OF CORROSION-INHIBITING MATERIALS

A. Apply corrosion-inhibiting treatment to [**surfaces indicated on Drawings, from wall to wall or curb to curb and from joint to joint in the perpendicular direction**].

B. Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete[**or applying a sealer or overlay**].

3.13 APPLICATION OF POLYMER-OVERLAY MATERIALS

A. Apply polymer overlay in accordance with ACI 503.3.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.14 APPLICATION OF POLYMER-SEALER MATERIALS

A. Apply polymer sealer by brush, roller, or airless spray at manufacturer's recommended application rate.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.15 INSTALLATION OF COMPOSITE REINFORCEMENT MATERIALS

A. Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, install as follows:

1. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
2. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
3. Apply epoxy saturant to [**fiber tow sheet**][**or**][**primed and patched surface**] using roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy to fully saturate tow sheet.
4. Apply additional layers using same procedure, fully saturating each layer with epoxy.
5. After saturant has cured, apply protective topcoat by [**brush**][**roller**][**or**][**spray**].

B. Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, install as follows:

1. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
2. Apply epoxy adhesive to a thickness of **1/16 inch (1.6 mm)** to prepared concrete surfaces.
3. Clean fiber sheet with acetone or other suitable solvent and apply epoxy adhesive to a thickness of **1/16 inch (1.6 mm)**.
4. Apply adhesive-coated fiber sheet to adhesive-coated concrete and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
5. Apply additional layers using same procedure.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Packaged, Cementitious Patching-Mortar Application: randomly selected sets of samples for each type of mortar required, tested in accordance with ASTM C928/C928M.
2. Job-Mixed Patching-Mortar Application: As directed by the Owner, randomly selected sets of samples for each type of mortar required, tested for compressive strength in accordance with ASTM C109/C109M.
3. Concrete: As specified in [**Section 033000 "Cast-in-Place Concrete."**][**Section 033300 "Architectural Concrete."**]
4. Grout for Preplaced Aggregate: Tested for compressive strength in accordance with ASTM C942/C942M.

    a. Testing Frequency: One sample for each **25 cu. yd. (19 cu. m)** of grout or fraction thereof,

but not less than one sample for each day's work.

5. Joint Filler: Core-drilled samples to verify proper installation.

   a. Testing Frequency: One sample for each **100 ft. (30 m)** of joint filled.
   b. Where samples are taken, refill holes with joint filler.

6. Epoxy Crack-Injection Materials: Core-drilled samples to verify proper installation.

   a. Testing Frequency: [**Three samples from mockup and**]one sample for each **100 ft. (30 m)** of crack injected.
   b. Where samples are taken, refill holes with epoxy mortar.

7. Product will be considered defective if it does not pass tests and inspections.

C. Manufacturers Field Service: Engage manufacturers' factory-authorized service representatives for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.

1. Have manufacturers' factory-authorized service representatives perform the following number of Project-site inspections to observe progress and quality of the Work, distributed over the period of product installation, regardless of on-site assistance requested by Architect:

   a. Bonding-Agent and Packaged Patching-Mortar Installation: [**Three**] inspections.
   b. Joint-Filler Installation: [**Two**] inspections.
   c. Crack-Injection-Adhesive Preparation and Installation: [**Four**] inspections.
   d. Corrosion-Inhibiting Treatment Installation: [**Two**] inspections.
   e. Polymer-Overlay Installation: [**Two**] inspections.
   f. Polymer Sealer: [**Two**] inspections.
   g. Composite-Structural Reinforcement: [**Three**] inspections.

D. Prepare test and inspection reports.

3.17 CONCRETE MAINTENANCE SCHEDULE

A. Garage Level 1 Entrance Ramp: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement on underside of slab.

B. Elevated Warehouse Floors: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement on underside of slab.

C. Concrete Walls and Floor in Salt Dome: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement of columns.

END OF SECTION 03 01 30 00

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Task	Specification	Specification Description
03 01 30 51	03 01 30 00	Maintenance of Cast-in-Place Concrete
03 01 30 71	01 11 19 00	No Specification Required
03 01 30 71	03 01 30 00	Maintenance of Cast-in-Place Concrete
03 01 30 72	03 01 30 00	Maintenance of Cast-in-Place Concrete
03 05 13 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 10 00 00 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing materials.
2. Form liners.
3. Insulating concrete forms.
4. Waterstops.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.
2. Section 321316 "Decorative Concrete Paving" for formwork related to decorative concrete pavement and walks.

1.2 DEFINITIONS

A. Form-Facing Material: The temporary form materials that come in direct contact with the concrete as part of the formwork components in supporting the concrete while the concrete is setting and gaining sufficient strength to be self-supporting. The most common materials are steel, aluminum, and wood.

B. Form Lining: Materials used to line the concreting face of formwork to impart a smooth or patterned finish to the concrete surface, to absorb moisture from the concrete, or to apply a set-retarding chemical to the formed surface of the concrete.

C. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction, movement, contraction, and isolation joints
c. Forms and form-removal limitations.
d. Shoring and reshoring procedures.
e. Anchor rod and anchorage device installation tolerances.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

C. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with **ACI 301 (ACI 301M)**.
3. Indicate location of waterstops.
4. Indicate form liner layout and form line termination details.
5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

D. Samples:

1. For waterstops.
2. For Form Liners: **12- by 12-inch (305- by 305-mm)** sample, indicating texture.

1.5 INFORMATIONAL SUBMITTALS

A. Research Reports: For insulating concrete forms indicating compliance with ICC's Acceptance Criteria AC353.

B. Field quality-control reports.

C. Minutes of preinstallation conference.

D. Qualification Statements: For testing and inspection agency.

1.6 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Mockups: As directed by the Owner, formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

1. Build panel approximately [**100 sq. ft. (9.3 sq. m)**] in the location indicated or, if not indicated, as directed by the Owner.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Form Liners: Store form liners under cover to protect from sunlight.

B. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with **ACI 301 (ACI 301M)**, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

    a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with **ACI 301 (ACI 301M)**, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:

    a. Wind Loads: As indicated on Drawings.

        1) Horizontal Deflection Limit: Not more than [**1/240**][**1/360**][**1/600**][**1/720**] of the wall height.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete, and as follows:

    a. Plywood, metal, or other approved panel materials.
    b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

        1) APA HDO (high-density overlay).
        2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
        3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.

4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces [**with gradual or abrupt irregularities**][**without spiral or vertical seams**] not exceeding specified formwork surface class.

1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with [**straight**][**or**][**tapered**] end forms.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

2.3 FORM LINERS

A. Form Liners: Architectural finish pattern on the concrete surface can be achieved by attaching form liners to the inside faces of form-facing materials.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Polymers, Inc.**]
b. [**Fitzgerald Formliners**]
c. [**Sika Corporation**]
d. [**Spec Formliners, Inc.**]

2. Face Pattern:
[**Smooth**][**Ribbed**][**Textured**][**Reveal**][**Geometric**][**Stone**][**Brick**][**Block**][**Rock**][**Wood**][**Custom**].

2.4 INSULATING CONCRETE FORMS

A. Insulating Concrete Forms: Concrete-forming system complying with ASTM E2634, consisting of two panels of insulation connected with cross ties.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alleguard (formerly Amvic Building System)**]
b. [**BuildBlock Building Systems, LLC**]
c. [**Fox Blocks; Airlite Plastics Co.**]

d. [**Nudura Corporation**]
e. [**Nudura, part of Tremco CPG**]

2. Insulation: ASTM C578, Type II, expanded polystyrene.

a. Thickness: Not less than [**2-1/2 inches (64 mm)**] each face.
b. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 450 or less.

3. Cross Ties: Polypropylene, with integral reinforcement supports, designed to allow passage of concrete during placement.
4. Core Thickness: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (201 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**].

2.5 WATERSTOPS

A. Flexible Rubber Waterstops: U.S. Army Corps of Engineers' CE CRD-C 513,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints, with factory-fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Williams Products, Inc.**]

2. Profile: [**Flat dumbbell with center bulb**][**Flat dumbbell without center bulb**][**Ribbed with center bulb**][**Ribbed without center bulb**][**As indicated**].
3. Dimensions: [**4 by 3/16 inch thick (100 by 4.8 mm thick)**][**6 by 3/8 inch thick (150 by 10 mm thick)**][**9 by 3/8 inch thick (225 by 10 mm thick)**]; nontapered.

B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops[**with factory-installed metal eyelets**], for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals, with factory-fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**J P Specialties, Inc.**]
b. [**Sika Corporation**]

2. Profile: [**Flat dumbbell with center bulb**][**Flat dumbbell without center bulb**][**Ribbed with center bulb**][**Ribbed without center bulb**][**As indicated**].
3. Dimensions: [**4 by 3/16 inch thick (100 by 4.8 mm thick)**][**6 by 3/16 inch thick (150 by 4.8 mm thick)**][**6 by 3/8 inch thick (150 by 10 mm thick)**][**9 by 3/16 inch thick**

(225 by 4.8 mm thick)][9 by 3/8 inch thick (225 by 10 mm thick)]; nontapered.

C. Flexible PVC Waterstops: U.S. Army Corps of Engineers' CE CRD-C 572,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints, with factory-fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BoMetals, Inc.**]
   b. [**Sika Corporation**]
   c. [**Vinylex Waterstop & Accessories**]

2. Profile: [**Flat dumbbell with center bulb**][**Flat dumbbell without center bulb**][**Ribbed with center bulb**][**Ribbed without center bulb**][**As indicated**].
3. Dimensions: [4 by 3/16 inch thick (100 by 4.8 mm thick)][6 by 3/8 inch thick (150 by 10 mm thick)][9 by 3/8 inch thick (225 by 10 mm thick)]; nontapered.

D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carlisle Coatings & Waterproofing Inc**]
   b. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
   c. [**Concrete Sealants Inc.**]
   d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
   e. [**J P Specialties, Inc.**]
   f. [**Sika Corporation**]

E. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
   b. [**GCP Applied Technologies Inc.**]
   c. [**Kryton International, Inc.**]
   d. [**OCM, Inc.**]
   e. [**Sika Corporation**]

2.6 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than **0.022-inch- (0.55-mm-)** thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than **0.034 inch (0.85 mm)** thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, **3/4 by 3/4 inch (19 by 19 mm)**, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners to be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than **1 inch (25 mm)** to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than **1 inch (25 mm)** in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

G. Sealant: One-part moisture cure silicone sealant used with form liners.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with **ACI 301 (ACI 301M)**.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of **ACI 117 (ACI 117M)** and to comply with the Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete" for as-cast finishes[.][**and Section 033300 "Architectural Concrete."**]

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: **ACI 117 (ACI 117M)** Class D, **1 inch (25 mm)**.
2. Surface Finish-2.0: **ACI 117 (ACI 117M)** Class B, **1/4 inch (6 mm)**.
3. Surface Finish-3.0: **ACI 117 (ACI 117M)** Class A, **1/8 inch (3.0 mm)**.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. [**Chamfer**][**Do not chamfer**] exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than **12 inches (305 mm)**.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.

L. Form Liners: Install per manufacturer's written installation instructions and recommended tolerances.

M. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as directed by the Owner.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

    a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls [**as indicated on Drawings**].

    a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

N. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.

2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

O. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

P. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

Q. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-in-Place Concrete."
4. Secure waterstops in correct position at **12 inches (305 mm)** o.c.
5. Field fabricate joints in accordance with manufacturer's written instructions using heat welding.
    a. Miter corners, intersections, and directional changes in waterstops.
    b. Align center bulbs.
6. Clean waterstops immediately prior to placement of concrete.
7. Support and protect exposed waterstops during progress of the Work.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, in accordance with manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Protect exposed waterstops during progress of the Work.

3.4 INSTALLATION OF INSULATING CONCRETE FORMS

A. Comply with **ACI 301 (ACI 301M)** and manufacturer's written instructions.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of **ACI 117 (ACI 117M)**.

C. Install forms in running bond pattern.

1. Align joints.
2. Align furring strips.

D. Construct forms tight to prevent loss of concrete mortar.

E. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.

F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

G. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

H. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

I. Shore insulating concrete forms to ensure stability and to resist stressing imposed by construction loads.

3.5 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than **50 deg F (10 deg C)** for [**24**] hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved[**at least 70 percent of**] its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by the Owner.

3.6 INSTALLATION OF SHORING AND RESHORING

A. Comply with **ACI 318 (ACI 318M)** and **ACI 301 (ACI 301M)** for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a [**special inspector**][**and**][**qualified testing and inspecting agency**] to perform field tests and inspections and prepare test reports.

B. Testing Agency: [**the Owner**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

D. Prepare test and inspection reports.

END OF SECTION 03 10 00 00

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Task	Specification	Specification Description
03 11 00 00	03 10 00 00	Concrete Forming and Accessories
03 11 13 00	01 11 19 00	No Specification Required
03 11 13 00	03 10 00 00	Concrete Forming and Accessories
03 11 13 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 11 16 00 - ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing materials.
2. Concrete materials.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete that apply to architectural concrete.
2. Section 033543 "Polished Concrete Finishing" for concrete polishing.

1.2 DEFINITIONS

A. Aggregate Exposure: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

B. Cast-in-Place Architectural Concrete: Concrete that is exposed to view, is designated as architectural concrete, and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

C. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

D. Design Reference Sample: Sample designated, as directed by the Owner in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.

E. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place architectural concrete Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.

c. Reinforcement accessory installation.
d. Cold- and hot-weather concreting procedures.
e. Concrete finishes and finishing.
f. Curing procedures.
g. Forms and form-removal limitations.
h. Shoring and reshoring procedures.
i. Concrete repair procedures.
j. Protection of cast-in-place architectural concrete.
k. Initial curing and field curing of field test cylinders (ASTM C31/C31M).
l. Protection of field-cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Form-facing panels.
2. Form liners.
3. Form joint tape.
4. Form joint sealant.
5. Wood sealer.
6. Form-release agent.
7. Surface retarder.
8. Form ties.
9. Bar supports.
10. Portland cement.
11. Fly ash.
12. Slag cement.
13. Blended hydraulic cement.
14. Natural or other pozzolans.
15. Silica fume.
16. Performance-based hydraulic cement.
17. Aggregates.
18. Admixtures:

    a. Include limitations of use.

19. Color pigments.
20. Repair materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight with no GreenScreen LT-1 or GHS Category 1 hazards.
    b. Inventory or HPD to at least 0.01 percent by weight, with at least 75 percent assessed using GreenScreen Benchmark assessment.
    c. Third-party-verified Declare product label, designated "Red List Free."

d. Material Health Certificate or Cradle to Cradle certification with minimum Bronze level of Material Health.

C. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Steel-fiber reinforcement content.
10. Synthetic microfiber content.
11. Amounts of mixing water to be withheld for later addition at Project site if permitted.
12. Intended placement method.
13. Alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Shop Drawings:

1. Formwork: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

a. Show formwork construction, including form-liner layout, form-liner termination details, dimensioned locations of form-facing material joints, rustications, construction and contraction joints, form joint-sealant details, form-tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

1) Included separate layout for formwork used in [**field sample panels**][**and**][**mockups**].
2) Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
3) Location of construction joints as directed by the Owner.

E. Samples: For each of the following materials:

1. Form-facing panels.
2. Form ties.
3. Form liners, **12-by-12-inch (305-by-305-mm)** Sample, indicating texture.
4. Manufacturer's standard colors for color pigment.
5. Exposed aggregates.
6. Chamfers and rustications.

F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately **18 by 18 by 2 inches (450 by 450 by 50 mm)**, of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

G. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.

4. Formed Surface Finish designation and final finish.
5. Curing process.

H. Placement Schedule: Submit before start of placement operations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Repair materials.

C. Material Test Reports: For the following, by a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates[**: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity**].

D. Research Reports: For concrete admixtures in accordance with ICC AC198.

E. Preconstruction Test Reports: For each mix design.

F. Concrete Repair: Submit a written, detailed description of materials, methods, equipment, and sequence of operations to be used for repairing architectural concrete, including protection of surrounding materials and Project site.

1. If materials and methods other than those indicated are proposed for any repairs to architectural concrete, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project and Installer's ability to use such materials and methods properly.

G. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete

Production Facilities."

B. Installer Qualifications: An experienced cast-in-place architectural concrete installer, as evidenced by not less than five consecutive years' experience, specializing in installing cast-in-place architectural concrete similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1. Provide written evidence of qualifications and experience.
2. Include locations, descriptions, and photographs of completed projects, substantiating the quality of the installer's experience, as directed by the Owner.

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Technical Manager.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level I.
2. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Level II.

D. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately **48 by 48 by 6 inches (1200 by 1200 by 150 mm)** minimum, to demonstrate the expected range of finish, color, and texture variations.

1. Locate panels as indicated or, if not indicated, as directed by the Owner.
2. Demonstrate methods of curing, aggregate exposure, wood sealers, and coatings, as applicable.
3. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces, as directed by the Owner.
4. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
5. Demolish and remove field sample panels when directed.

E. Mockups: Before casting architectural concrete, build mockups, using the same procedures, equipment, materials, finishing procedures, and curing procedures that will be used for producing architectural concrete, to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, color, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by the Owner.
2. Build mockups of typical wall of cast-in-place architectural concrete as shown on Drawings, including vertical and horizontal rustication joints, and any sculptured features.
3. Construct mockups to include at least two lifts having heights equal to those anticipated for construction.
4. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
5. Damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces, as directed by the Owner.
6. Demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces, as directed by the Owner.
7. Approval of mockups before casting architectural concrete, as directed by the Owner.
8. Subject to compliance with requirements, approved mockups may become part of the completed

Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Permeability.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and **ACI 301 (ACI 301M)**.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."

B. Hot-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless modified by requirements in the Contract Documents.

2.2 FORM-FACING MATERIALS

A. Comply with Section 031000 "Concrete Forming and Accessories" for formwork and other form-facing material requirements, and as specified in this Section.

B. Source Limitations: Obtain each type of form-facing material from single source from single manufacturer.

C. Form-Facing Panels:

1. Finishes: [**As cast**][**or**][**exposed aggregate**].

a. Steel- and glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

b. Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces, [**high-density overlay, Class 1, or better**][**medium-density overlay, Class 1, or better, mill-applied release agent and edge sealed**], complying with DOC PS 1[**, or Finnish phenolic overlaid birch plywood**].

D. Form Liners: Units of face design, texture, arrangement, and configuration [**indicated**][**to match design reference sample**]. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments and finishes of concrete.

E. Rustication Strips: Metal[**, dressed wood,**] or rigid plastic, with sides beveled and back kerfed; nonstaining; in longest practicable lengths.

F. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, **3/4 by 3/4 inch (19 by 19 mm)**, minimum; nonstaining; in longest practicable lengths.

G. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum **1/4 inch (6 mm)** thick.

H. Form Joint Sealant: Elastomeric sealant complying with ASTM C920, Type M or Type S, Grade NS, that adheres to form joint substrates, does not stain, does not adversely affect concrete surfaces, and does not impair subsequent treatments and finishes of concrete surfaces.

I. Wood Sealer: Penetrating, clear, polyurethane wood sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood and does not stain, does not adversely affect concrete surfaces, and does not impair subsequent treatments and finishes of concrete surfaces.

J. Form-Release Agent: Commercially formulated, colorless form-release agent that does not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments and finishes of architectural concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form-release agent for form liners to be acceptable to form-liner manufacturer.

K. Surface Retarder: Water-soluble chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed architectural concrete surface to depth of aggregate exposure specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**Master Builders Solutions**]
   c. [**W. R. Meadows, Inc**]

2. Source Limitations: Obtain surface retarder from single source from single manufacturer.

L. Form Ties: Factory-fabricated, [**glass-fiber-reinforced plastic**][**internally disconnecting**][**or**][**removable**] ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish ties[**with tapered tie cone spreaders**] that, when removed, will leave holes no larger

than [3/4 inch (19 mm)][1 inch (25 mm)][1-1/4 inches (32 mm)][1-1/2 inches (38 mm)] in diameter on architectural concrete surface.

2. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm)[, **after exposing aggregate,**] from architectural concrete surface.
3. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) and not more than 1 inch (25 mm) in diameter, of color, as directed by the Owner
4. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place.

1. Manufacture bar supports in accordance with CRSI's "Manual of Standard Practice."
2. Where legs of wire bar supports contact forms, use [**gray, all-plastic**][**CRSI Class 1, gray, plastic-protected**][**or**][**CRSI Class 2, stainless steel**] bar supports.

2.4 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within 100 miles (160 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Indigenous Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**][**Type III**], [**gray**][**white**].
2. Pozzolans: [**ASTM C618, Class C**][**ASTM C618, Class F**][**ASTM C618, Class N**][**Not allowed**].
3. Slag Cement: [**ASTM C989/C989M, Grade 100 or Grade 120**][**Not allowed**].
4. Silica Fume: [**ASTM C1240**][**Not allowed**].

D. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 5S**][**Class 5M**][**Class 1N**] coarse aggregate or better, graded. Provide aggregates from single source from single manufacturer.

1. Alkali-Silica Reaction: Comply with one of the following:

   a. Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
   b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at 16 days when tested in accordance with ASTM C1567.
   c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. (2.37 kg/cu. m) for moderately reactive aggregate or 3 lb./cu. yd. (1.78 kg/cu. m) for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).

2. Maximum Coarse-Aggregate Size: [1 inch (25 mm)][3/4 inch (19 mm)][1/2 inch (13 mm)][3/8 inch (10 mm)].
3. Gradation: [**Uniformly**][**Gap**] graded.

E. Normal-Weight Fine Aggregate: [**ASTM C33/C33M**][**or**][**ASTM C144**], manufactured or natural sand, free of materials with deleterious reactivity to alkali in cement, from same source for entire Project.

F. Air-Entraining Admixture: As specified in Section 033000 "Cast-in-Place Concrete."

G. Chemical Admixtures: As specified in Section 033000 "Cast-in-Place Concrete," and certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

H. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alabama Pigments Company, LLC**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Dynamic Color Solutions, Inc**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Hoover Color Corporation**]
h. [**Lambert Corporation**]
i. [**Lanxess Corporation**]
j. [**Master Builders Solutions**]
k. [**Matcrete Inc.**]
l. [**NewLook International, Inc.**]
m. [**Proline Concrete Tools, Inc.**]
n. [**QC Construction Products**]
o. [**Scofield, a Business Unit of Sika Corporation**]
p. [**Solomon Colors Inc.**]
q. [**Stampcrete International, Ltd**]
r. [**SureCrete Design Products, a Fenix Group SPC Company**]
s. [**Venator Materials PLC**]

2. Source Limitations: Obtain color pigment from single source from single manufacturer.
3. Color: [**As indicated by manufacturer's designation**][**as directed by the Owner**].

I. Water and Water Used to Make Ice: ASTM C94/C94M, potable [**or**][**complying with ASTM C1602/C1602M, including all limits listed in Table 2 and requirements of paragraph 5.4**].

2.5 CURING MATERIALS

A. Comply with Section 0330000 "Cast-in-Place Concrete."

1. For integrally colored concrete, curing materials to be approved by color pigment manufacturer.
2. For concrete indicated to be sealed, curing materials to be compatible with sealer.

2.6 REPAIR MATERIALS

A. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

B. Epoxy Bonding Adhesive: ASTM C881/C881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements.

1. [**Types I and II, non-load bearing**][**Types IV and V, load bearing**], for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES, GENERAL

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, in accordance with **ACI 301 (ACI 301M)**.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs, based on laboratory trial mixtures.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

D. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

E. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved [**design reference sample**][**field sample panels**][**mockups**].

2.8 CONCRETE MIXTURES

A. Class:

1. Normal-Weight Concrete: [**K**].
2. Exposure Class: **ACI 318 (ACI 318M)** [**F0**][**F1**][**F2**][**F3**][**S0**][**S1**][**S2**][**S3**][**W0**][**W1**][**C0**][**C1**][**C2**].
3. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at 28 days.
4. Maximum w/cm: 0.46.
5. Slump Limit: [**3 inches (75 mm), plus or minus 1 inch (25 mm)**][**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing**

admixture or plasticizing admixture at Project site].

6. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
7. Air Content:

    a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

    b. Exposure Classes F2 and F3: [**6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

8. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

2.9 CONCRETE MIXING

A. Architectural Concrete:

1. [**Ready mixed**][**or**][**project-site mixed**]. Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M[**and ASTM C1116/C1116M**], and furnish batch ticket information.

    a. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
    b. For mixer capacity of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
    c. For mixer capacity larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
    d. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with Section 031000 "Concrete Forming and Accessories" for formwork, embedded items, and shoring and reshoring, and as specified in this Section.

B. Limit deflection of form-facing panels to not exceed **ACI 301 (ACI 301M)** requirements.

C. Limit cast-in-place architectural concrete surface irregularities, as follows:

1. Surface Finish-1.0: **ACI 117 (ACI 117M)** Class D, **1 inch (25 mm)**.
2. Surface Finish-2.0: **ACI 117 (ACI 117M)** Class B, **1/4 inch (6 mm)**.
3. Surface Finish-3.0: **ACI 117 (ACI 117M)** Class A, **1/8 inch (3.0 mm)**.

D. Construct forms to result in cast-in-place architectural concrete that complies with **ACI 117 (ACI 117M)**.

E. Seal form joints, chamfers, rustication joints, and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.

1. Provide closure backing materials if indented rustication is used over a ribbed form line, and seal joint between rustication strip and form with joint sealant.

F. [**Chamfer**][**Do not chamfer**] exterior corners and edges of cast-in-place architectural concrete.

G. Coat contact surfaces of wood rustications and chamfer strips with wood sealer before placing reinforcement, anchoring devices, and embedded items.

H. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

I. Coat contact surfaces of forms with surface retarder, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

J. Place form liners accurately to provide finished surface texture indicated.

1. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting.
2. Secure form liners in place using fasteners that will not transfer impressions onto surface of concrete.
3. Prevent form liners from sagging and stretching in hot weather.
4. Seal joints of form liners and form-liner accessories to prevent mortar leaks.
5. Coat form liner with form-release agent.

3.2 INSTALLATION OF REINFORCEMENT AND ACCESSORIES

A. Comply with Section 032000 "Concrete Reinforcing" for fabricating and installing steel reinforcement and accessories.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than **50 deg F (10 deg C)** for [**24**] hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Schedule form removal to maintain surface appearance that matches approved [**design reference sample**][**field sample panels**][**mockups**].
2. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved[**at least 70 percent of**] its 28-day design compressive strength.
3. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
4. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.4 JOINTS

A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated as directed by the Owner.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Form keyed joints as indicated.[**Embed keys at least 1-1/2 inches (38 mm) into concrete.**] Align construction joint within rustications attached to form-facing material.
3. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at top of footings or floor slabs.
5. Space vertical joints in walls [**as indicated on Drawings**]. Unless otherwise indicated on Drawings, locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use [**bonding agent**][**epoxy-bonding adhesive**] at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

B. Contraction Joints: Form weakened-plane contraction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated on Drawings, as directed by the Owner.

3.5 CONCRETE PLACEMENT

A. Comply with Section 033000 "Cast-in-Place Concrete."

3.6 FINISHING FORMED SURFACES

A. Comply with Section 033000 "Cast-in-Place Concrete."

B. Architectural Concrete Finish: Match design reference sample, identified and described as indicated, as directed by the Owner.

C. As-Cast Surface Finishes: Comply with Section 033000 "Cast-in-Place Concrete" for the following:

1. **ACI 301 (ACI 301M)** Surface Finish-1.0 (SF-1.0).
2. **ACI 301 (ACI 301M)** Surface Finish-2.0 (SF-2.0).
3. **ACI 301 (ACI 301M)** Surface Finish-3.0 (SF-3.0).

D. Final Concrete Finish: Comply with Section 033000 "Cast-in-Place Concrete" for the following:

1. Smooth-rubbed finish.
2. Grout-cleaned rubbed finish.
3. Cork-floated finish.
4. Abrasive-blast finish.
5. Scrubbed finish.
6. High-pressure water-jet finish.
7. Bushhammer finish.

E. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

F. Maintain uniformity of architectural concrete finishes over construction joints unless otherwise indicated.

3.7 CONCRETE CURING

A. Comply with Section 033000 "Cast-in-Place Concrete" using identical curing procedures to that used for [**field sample panels**][**mockups**].

3.8 REPAIR

A. Comply with **ACI 301 (ACI 301M)**.

B. Repair damaged finished surfaces of cast-in-place architectural concrete when repairing, as directed by the Owner.

C. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved [**field sample panels**][**mockups**].

D. Remove and replace cast-in-place architectural concrete that cannot be repaired, as directed by the Owner.

3.9 FIELD QUALITY CONTROL

A. Comply with Section 033000 "Cast-in-Place Concrete."

3.10 CLEANING

A. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

B. Wash and rinse surfaces in accordance with concrete finish applicator's written instructions.

1. Protect other Work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

3.11 PROTECTION

A. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards

and barricades.

B. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

3.12 FINAL ACCEPTANCE

A. Final acceptance of completed architectural concrete Work by comparing approved [**design reference sample**][**field sample panels**][**mockups**] with installed Work, when viewed at a distance of [**20 feet (6 m)**], as directed by the Owner.

END OF SECTION 03 11 16 00

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Task	Specification	Specification Description
03 11 16 00	03 10 00 00	Concrete Forming and Accessories
03 11 16 13	03 10 00 00	Concrete Forming and Accessories
03 11 16 13	03 30 00 00	Cast-In-Place Concrete
03 11 16 13	03 11 16 00	Architectural Concrete
03 11 23 00	01 11 19 00	No Specification Required
03 11 23 00	03 10 00 00	Concrete Forming and Accessories
03 11 23 00	03 30 00 00	Cast-In-Place Concrete
03 15 00 00	03 10 00 00	Concrete Forming and Accessories
03 15 13 00	03 10 00 00	Concrete Forming and Accessories
03 15 13 13	03 10 00 00	Concrete Forming and Accessories
03 15 13 13	03 30 00 00	Cast-In-Place Concrete
03 15 13 16	03 10 00 00	Concrete Forming and Accessories
03 15 13 16	03 30 00 00	Cast-In-Place Concrete
03 15 16 00	03 10 00 00	Concrete Forming and Accessories
03 15 16 00	03 30 00 00	Cast-In-Place Concrete
03 15 19 00	03 10 00 00	Concrete Forming and Accessories
03 15 19 00	05 50 00 00	Metal Fabrications

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SECTION 03 20 00 00 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

B. Related Requirements:

1. Section 033816 "Unbonded Post-Tensioned Concrete" for reinforcing related to post-tensioned concrete.
2. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural concrete.
3. Section 034500 "Precast Architectural Concrete" for reinforcing used in precast architectural concrete.
4. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.
5. Section 321316 "Decorative Concrete Paving" for reinforcing related to decorative concrete pavement and walks.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction contraction and isolation joints.
c. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Epoxy repair coating.
3. Zinc repair material.
4. Bar supports.
5. Mechanical splice couplers.
6. Structural thermal break insulated connection system.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Type III Environmental Product Declaration (EPD): For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
13. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

C. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.

D. Delegated Design Submittal: For structural thermal break insulated connection system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**delegated design engineer**][**testing and inspection agency**].

B. Delegated Design Engineer Qualifications: Include the following:

1. Experience providing delegated design engineering services of the type indicated.
2. Documentation that delegated design engineer is licensed in the [**jurisdiction**][**state**] in which Project is located.

C. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

D. Material Certificates: For each of the following, signed by manufacturers:

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

E. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

C. Mockups: Reinforcing for cast-concrete formed surfaces, to demonstrate tolerances and standard of workmanship.

1. Build panel approximately [**100 sq. ft. (9.3 sq. m) for formed surface**] in the location indicated on Drawings or, if not indicated, as directed by the Owner.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage[**and to avoid damaging coatings on steel reinforcement**].

1. Store reinforcement to avoid contact with earth.
2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design structural thermal break insulated connection system, including attachment to building construction.

B. Structural Performance of Structural Thermal Break Insulating Connection System: Structural thermal break insulated connection system to withstand the following loads and stresses:

1. Dead Loads: As indicated on Drawings.

a. Shear Load: As indicated on Drawings.
b. Bending Moment: As indicated on Drawings.

2. Live Loads: As indicated on Drawings.

a. Shear Load: As indicated on Drawings.
b. Bending Moment: As indicated on Drawings.

C. Seismic Performance of Structural Thermal Break Insulated Connection System: Structural thermal break Insulated connection system to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 STEEL REINFORCEMENT

A. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

1. Regional Materials: Steel shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
2. Regional Materials: Steel shall be manufactured within **500 miles (800 km)** of Project site.
3. Regional Materials: Steel shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
4. Indigenous Materials: Steel shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
5. Regional Materials: Steel shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

B. Reinforcing Bars: ASTM A615/A615M, [**Grade 60 (Grade 420)**][**Grade 75 (Grade 520)**][**Grade 80 (Grade 550)**][**Grade 100 (Grade 690)**], deformed.

C. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

D. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

E. Galvanized Reinforcing Bars:

1. Steel Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A615/A615M, Grade 75 (Grade 520)**][**ASTM A615/A615M, Grade 80 (Grade 550)**][**ASTM A615/A615M, Grade 100 (Grade 690)**][**ASTM A706/A706M**], deformed bars.
2. Zinc Coating: ASTM A767/A767M, [**Class I**][**Class II**] zinc coated after fabrication and bending.

F. Epoxy-Coated Reinforcing Bars:

1. Steel Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A615/A615M, Grade 75 (Grade 520)**][**ASTM A615/A615M, Grade 80 (Grade 550)**][**ASTM A615/A615M, Grade 100 (Grade 690)**][**ASTM A706/A706M**], deformed bars.
2. Epoxy Coating: [**ASTM A775/A775M**][**or**][**ASTM A934/A934M**] with less than 2 percent damaged coating in each **12-inch (305-mm)** bar length.

G. Dual-Coated Reinforcing Bars: ASTM A1055/A1055M.

1. Steel Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A615/A615M, Grade 75 (Grade 520)**][**ASTM A615/A615M, Grade 80 (Grade 550)**][**ASTM A615/A615M, Grade 100**

(Grade 690)][**ASTM A706/A706M**], deformed bars.
2. Zinc Coating: ASTM A1055/A1055M [**Type I**][**Type II**].
3. Epoxy Coating: [**ASTM A775/A775M**][**or**][**ASTM A934/A934M**] with less than 2 percent damaged coating in each **12-inch (300-mm)** bar length.

H. Stainless Steel Reinforcing Bars: ASTM A955/A955M, [**Grade 60 (Grade 420)**][**Grade 75 (Grade 520)**], [**Type 304**][**Type 316L**], deformed.

I. Steel Bar Mats: ASTM A184/A184M, fabricated from [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A615/A615M, Grade 40 (Grade 280)**][**ASTM A706/A706M**], deformed bars, assembled with clips.

J. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

K. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

L. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.

M. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A coated, Type 1, [**plain**][**deformed**] steel.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, plain-steel bars, ASTM A775/A775M epoxy coated.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

   a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
   b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
   c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
   d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
   e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

D. Mechanical Splice Couplers: **ACI 318 (ACI 318M)** [**Type 1**][**Type 2**], same material of reinforcing bar being spliced; [**compression-only type**][**tension-compression type**][**dowel-bar type**][**mechanical-lap type**].

E. Structural Thermal Break Insulated Connection System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Halfen USA, Inc.**]

2. Tension Rods: [**Carbon steel with crimped Type 316 stainless steel rods**][**Carbon steel, welded with ASTM A276/A276M, Type 316 stainless steel**].
3. Shear Reinforcement Rods: [**ASTM A276/A276M, Type 316 stainless steel tube**][**Carbon steel, welded with ASTM A276/A276M, Type 316 stainless steel bar**].
4. Pressure pads: ASTM A276/A276M, Type 316 stainless steel.
5. Insulation body: Polystyrene.

F. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than **0.0508 inch (1.2908 mm)** in diameter.

1. Finish: [**Plain**][**Galvanized**][**ASTM A884/A884M, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating in each 12-inch (305-mm) wire length**].

G. Stainless Steel Tie Wire: ASTM A1022/A1022M, not less than **0.0508 inch (1.2908 mm)** in diameter.

H. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

I. Zinc Repair Material: ASTM A780/A780M.

2.4 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than **1 inch (25 mm)**, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with **ACI 318 (ACI 318M)**.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or **24 inches (610 mm)**, whichever is greater.
2. Stagger splices in accordance with **ACI 318 (ACI 318M)**.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install structural thermal break insulated connection system in accordance with manufacturer's instructions.

H. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

   a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed **12 inches (305 mm)**.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus **2 inches (50 mm)** for plain wire and **8 inches (200 mm)** for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

I. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.

J. Dual-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.

K. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material in accordance with ASTM A780/A780M.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as directed by the Owner.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with **ACI 117 (ACI 117M)**.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a [**special inspector**][**and**][**qualified testing and inspecting agency**] to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 03 20 00 00

Task	Specification	Specification Description
03 21 00 00	03 20 00 00	Concrete Reinforcing
03 21 11 00	03 20 00 00	Concrete Reinforcing
03 21 11 00	03 30 00 00	Cast-In-Place Concrete
03 21 13 00	03 20 00 00	Concrete Reinforcing
03 21 16 00	03 20 00 00	Concrete Reinforcing
03 21 16 00	03 30 00 00	Cast-In-Place Concrete
03 21 19 00	03 20 00 00	Concrete Reinforcing
03 22 00 00	03 20 00 00	Concrete Reinforcing
03 22 11 00	03 20 00 00	Concrete Reinforcing
03 22 11 00	03 30 00 00	Cast-In-Place Concrete
03 22 13 00	03 20 00 00	Concrete Reinforcing
03 22 13 00	03 30 00 00	Cast-In-Place Concrete
03 22 16 00	03 20 00 00	Concrete Reinforcing
03 22 16 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 30 00 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Fiber reinforcement.
5. Vapor retarders.
6. Floor and slab treatments.
7. Liquid floor treatments.
8. Curing materials.
9. Accessories.
10. Repair materials.
11. Concrete mixture materials.
12. Concrete mixture class types.
13. Concrete mixing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
4. Section 033543 "Polished Concrete Finishing" for concrete floors scheduled to receive a polished concrete finish.
5. Section 035300 "Concrete Topping" for concrete floor toppings.
6. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
7. Section 321313 "Concrete Paving" for concrete pavement and walks.
8. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement or blended hydraulic cement alone or in combination with one or more of the following:

1. Fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cementitious Materials (w/cm) Ratio: The ratio by weight of mixing water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for inspections and acceptance testing of concrete at Project site.
    c. Ready-mix concrete manufacturer.
    d. Concrete Subcontractor.
    e. Special concrete finish Subcontractor.

2. Review the following:

    a. Special inspection and testing and inspecting agency procedures for field quality control.
    b. Construction joints, control joints, isolation joints, and joint-filler strips.
    c. Semirigid joint fillers.
    d. Vapor-retarder installation.
    e. Anchor rod and anchorage device installation tolerances.
    f. Cold- and hot-weather concreting procedures.
    g. Concrete finishes and finishing.
    h. Curing procedures.
    i. Forms and form-removal limitations.
    j. Shoring and reshoring procedures.
    k. Methods for achieving specified floor and slab flatness and levelness.
    l. Floor and slab flatness and levelness measurements.
    m. Concrete repair procedures.
    n. Concrete protection.
    o. Initial curing of standard-cured and field curing of field-cured test cylinders (ASTM C31/C31M.)
    p. Protection of field cured field test cylinders.
    q. Distribution of test reports.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral fillers.
10. Admixtures:

    a. Include limitations of use. Admixtures that do not comply with reference ASTM International requirements must be submitted with test data for approval.

11. Color pigments.
12. Fiber reinforcement.
13. Vapor retarders.
14. Floor and slab treatments.
15. Liquid floor treatments.

16. Curing materials.

    a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.

17. Joint fillers.
18. Repair materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Laboratory Test Reports: For [**liquid floor treatments**][**and**][**curing and sealing compounds**], indicating compliance with requirements for low-emitting materials.
4. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight with no GreenScreen LT-1 or GHS Category 1 hazards.
    b. Inventory or HPD to at least 0.01 percent by weight, with at least 75 percent assessed using GreenScreen Benchmark assessment.
    c. Third-party-verified Declare product label, designated "Red List Free."
    d. Material Health Certificate or Cradle to Cradle certification with minimum Bronze level of Material Health.

C. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Compressive strength at 28 days or other age as specified.
3. Compressive strength required at stages of construction.
4. Durability exposure classes for Exposure Categories F, S, W, and C.
5. Maximum w/cm ratio.
6. Calculated equilibrium and fresh density for lightweight concrete.
7. Slump or slump flow limit.
8. Air content.
9. Nominal maximum aggregate size.
10. Steel-fiber reinforcement content.
11. Synthetic microfiber content.
12. Synthetic macrofiber content.
13. Intended placement method.
14. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

D. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

E. Samples: For [**manufacturer's standard colors for color pigment**][**vapor retarder**].

F. Concrete Schedule: For each location of each class of concrete indicated in "Concrete Mixture Class Types" Article, including the following:

1. Concrete class designation.
2. Location within Project.
3. Exposure class designation.
4. Formed surface finish designation and final finish.
5. Final finish for floors.
6. Floor treatment, if any.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Testing Agency: Include documentation indicating compliance with ASTM E329 or ASTM C1077 and copies of applicable ACI certificates for testing technicians or ACI Concrete Construction Special Inspector - MH, ASCC.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

C. Material Test Reports: For the following:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral filler.
10. Admixtures.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances in accordance with ACI 117 and in compliance with **ASTM E1155 (ASTM E1155M)**.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC's Acceptance Criteria AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician or an ACI Concrete Flatwork Finisher with experience installing and finishing concrete.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer's production facilities and delivery vehicles certified in accordance with NRMCA's certification requirements or equivalent approval by a State DOT.

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing that performs duties as directed by the Owner.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level 1. Testing agency laboratory supervisor tests to be an ACI-certified Concrete Laboratory Testing Technician, Level 2.

D. Field Quality-Control Testing Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests on plastic concrete properties are to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with policies from ACI CPP 610.1 or an equivalent certification program.

E. Mockups: Cast concrete [**slab-on-ground**][**and**][**formed-surface**] panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship. Provide up to two batches of concrete to demonstrate the number of required mockups.

1. Slab-on-Ground: Build panel in the location indicated or, if not indicated, as directed by the Owner.

a. Divide panel into four equal panels to demonstrate saw joint cutting.

2. Formed Surfaces: Build panel in the location indicated or, if not indicated, as directed by the Owner.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

    a. Admixture dosage rates.
    b. Slump.
    c. Air content.
    d. Seven-day compressive strength.
    e. 28-day compressive strength.
    f. Evaluation of permeability-reducing admixtures.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and **ACI 301 (ACI 301M)**.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with **ACI 301 (ACI 301M)** as follows:

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When air temperature has fallen to, or is expected to fall below **40 deg F (4.4 deg C)** during the protection period, maintain delivered concrete mixture temperature within the temperature range required by **ACI 301 (ACI 301M)**.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than **35 deg F (1.7 deg C)**, other than reinforcing steel.

B. Hot-Weather Placement: Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)**, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed [**95 deg F (35 deg C)**][**other permitted limit**].
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Indigenous Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type of admixture from single source from single manufacturer.

D. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**][**Type III**][**Type V**], [**gray**][**white**].
2. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, Portland-pozzolan**][**Type IL, portland-limestone**][**Type IT, ternary blended**] cement.
3. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: [**Type GU, general use**][**Type HE, high early strength**][**Type MS, moderate sulfate resistance**][**Type HS, high sulfate resistance**][**Type MH, moderate heat of hydration**][**Type LH, low heat of hydration**].
4. Pozzolans: ASTM C618, Class C, F, or N.
5. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
6. Ground Glass Pozzolan: ASTM C1866/C1866M, Type GS or GE.
7. Silica Fume: ASTM C1240.

E. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33/C33M, [**Class 3S**][**Class 3M**][**Class 1N**].
2. Maximum Coarse-Aggregate Size: [**1-1/2 inches (38 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**] nominal.
3. Fine Aggregate: ASTM C33/C33M.
4. Recycled Aggregate: Provide documentation of characteristics of recycled aggregate and mechanical properties and durability of proposed concrete, which incorporates recycled aggregate to conform to appliable requirements for the class of concrete.
5. Alkali-Silica Reaction: Comply with one of the following for each aggregate used:

a. Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567. Do not use this option with fly ash with an alkali content greater than 4.0 percent. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent when tested in accordance with ASTM C1260.
c. Alkali Content in Concrete: Not to exceed **4 lb./cu. yd. (2.37 kg/cu. m)** for aggregate with expansion greater than or equal to 0.04 percent and less than 0.12 percent or **3 lb./cu. yd. (1.78 kg/cu. m)** for aggregate with expansion greater than or equal to 0.12 percent and less than 0.24 percent. Test aggregate reactivity in accordance with ASTM C1293. Calculate alkali content of concrete in accordance with **ACI 301 (ACI 301M)**. Do not use this option with natural pozzolan or fly ash that has a calcium oxide content greater than 18 percent or an alkali content greater than 4.0 percent; or for an aggregate with expansion at one year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293.

F. Lightweight Aggregate: ASTM C330/C330M, [1-inch (25-mm)][3/4-inch (19-mm)][1/2-inch (13-mm)][3/8-inch (10-mm)] nominal maximum aggregate size.

1. Limit lightweight aggregate for internal curing to prewetted lightweight fine aggregate in accordance with ASTM C1761/C1761M.

G. Ground Calcium Carbonate or Aggregate Mineral Filler: ASTM C1797. Unless otherwise permitted, do not use mineral filler derived from carbonate sources in concrete for members assigned to Exposure Class S1, S2, or S3.

2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260/C260M.

B. Chemical Admixtures: Do not use calcium chloride or admixtures containing calcium chloride[**in steel-reinforced concrete**].

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494/C494M, Type S.
7. Set-Accelerating Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**MAPEI Corporation**]
4) [**Master Builders Solutions**]
5) [**Sika Corporation**]

8. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline or colloidal [**nano-**]silica admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**AQUAFIN, Inc**]
2) [**AVECS LLC**]
3) [**Barrier One, Inc.**]
4) [**Bone Dry Products, Inc.**]
5) [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
6) [**ISE Logik Industries, Inc.**]
7) [**Kryton International, Inc.**]

8) [**Master Builders Solutions**]
9) [**Penetron USA, Inc.**]
10) [**Xypex Chemical Corporation**]

b. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRD C48 at a hydraulic pressure of **200 psi (1.28 MPa)** for 14 days.

9. Moisture-Vapor-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, moisture-vapor-reducing, capable of reducing water absorption in and moisture-vapor emission from concrete (MVRA).

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**AQUAFIN, Inc**]
2) [**AVECS LLC**]
3) [**Barrier One, Inc.**]
4) [**Bone Dry Products, Inc.**]
5) [**Concure Products Inc.**]
6) [**ISE Logik Industries, Inc.**]
7) [**Kryton International, Inc.**]
8) [**Master Builders Solutions**]
9) [**Moxie International**]
10) [**Xypex Chemical Corporation**]

C. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments, color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alabama Pigments Company, LLC**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Dynamic Color Solutions, Inc**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Hoover Color Corporation**]
h. [**Lambert Corporation**]
i. [**Lanxess Corporation**]
j. [**Master Builders Solutions**]
k. [**Matcrete Inc.**]
l. [**NewLook International, Inc.**]
m. [**Proline Concrete Tools, Inc.**]
n. [**QC Construction Products**]
o. [**Scofield, a Business Unit of Sika Corporation**]
p. [**Solomon Colors Inc.**]
q. [**Stampcrete International, Ltd**]
r. [**SureCrete Design Products, a Fenix Group SPC Company**]
s. [**Venator Materials PLC**]

2. Color: [**As indicated by manufacturer's designation**][**as directed by the Owner**].

D. Mixing Water for Concrete Mixtures and Water Used to Make Ice: ASTM C1602/C1602M. Include documentation of compliance with limits for alkalis, sulfates, chlorides, or solids content of mixing water from Table 2 in ASTM C1602/C1602M.

2.4 FIBER REINFORCEMENT

A. Carbon-Steel-Wire Fiber: ASTM A820/A820M, Type 1, cold-drawn wire, deformed, minimum of [**1.5 inches (38 mm)**][**2 inches (50 mm)**][**2.4 inches (60 mm)**] long, with an aspect ratio of [**35 to 40**][**45 to 50**][**60 to 65**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bekaert**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**Sika Corporation**]

B. Carbon-Steel Cut Sheet Fiber: ASTM A820/A820M, Type 2, cut sheet, deformed, minimum of [**1.5 inches (38 mm)**][**2 inches (50 mm)**][**2.4 inches (60 mm)**] long, and aspect ratio of [**35 to 40**][**45 to 50**][**60 to 65**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Concrete Fiber Solutions**]
b. [**Fibercon International, Inc.**]
c. [**Sika Corporation**]

C. Synthetic Monofilament Microfiber: Monofilament polypropylene microfibers complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**][**1 to 2-1/4 inches (25 to 57 mm)**] long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FullForce by ABC Polymer Industries, LLC**]
c. [**GCP Applied Technologies Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

D. Synthetic Fibrillated Microfiber: Fibrillated polypropylene microfibers complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**][**1 to 2-1/4 inches (25 to 57 mm)**] long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FullForce by ABC Polymer Industries, LLC**]
c. [**GCP Applied Technologies Inc.**]
d. [**Master Builders Solutions**]
e. [**Sika Corporation**]

E. Synthetic Macrofiber: Synthetic macrofibers complying with ASTM C1116/C1116M, Type III, [**1 to 2-1/4 inches (25 to 57 mm)**] long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FullForce by ABC Polymer Industries, LLC**]
c. [**GCP Applied Technologies Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

2.5 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A[**, except with maximum water-vapor permeance of**]. Include manufacturer's recommended thickness and adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barrier-Bac; Inteplast Group**]
b. [**Foxfire Enterprises, Inc.**]
c. [**ISI Building Products**]
d. [**Poly-America, L.P.**]
e. [**R&D Workshop**]
f. [**Reef Industries, Inc.**]
g. [**Stego Industries, LLC**]
h. [**Tex-Trude**]
i. [**Viaflex**]
j. [**W. R. Meadows, Inc**]

B. Sheet Vapor Retarder, Class C: ASTM E1745, Class C[**, except with maximum water-vapor**

permeance of]; not less than **10 mils (0.25 mm)** thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ISI Building Products**]
    b. [**Stego Industries, LLC**]
    c. [**Tex-Trude**]
    d. [**Viaflex**]

C. Sheet Vapor Retarder/Termite Barrier: ASTM E1745, Class A, except with maximum water-vapor permeance of 0.03 perms; complying with ICC Acceptance Criteria AC380. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Polyguard Products, Inc.**]

2. Low-Temperature Flexibility: Pass at **minus 15 deg F (minus 26 deg C)**; ASTM D146/D146M.
3. Puncture Resistance: **224 lbf (996 N)** minimum; ASTM E154/E154M.
4. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at **70 deg F (21 deg C)**; ASTM D570.
5. Hydrostatic-Head Resistance: **231 ft. (70 m)** minimum; ASTM D5385/D5385M.

D. Bituminous Vapor Retarder: ASTM E1993/E1993M, **110-mil- (2.8-mm-)** thick, semiflexible, seven-ply sheet membrane, consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weather coating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**W. R. Meadows, Inc**]

2. Water-Vapor Permeance: **0.0011 grains/h x sq. ft. x inches Hg (0.063 ng/Pa x s x sq. m)** when tested in accordance with ASTM E154/E154M.
3. Tensile Strength: **156 lbf/inch (27.35 kN/m)** when tested in accordance with ASTM E154/E154M.
4. Puncture Resistance: **140 lbf (662 N)** when tested in accordance with ASTM E154/E154M.

2.6 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20

percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing [3/8-inch (10-mm)][No. 4 (4.75-mm)][No. 8 (2.36-mm)] sieve.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anti-Hydro International, Inc**]
    b. [**Dayton Superior Corporation**]
    c. [**Lambert Corporation**]
    d. [**Laticrete International, Inc.**]
    e. [**Metalcrete Industries**]

B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anti-Hydro International, Inc**]
    b. [**Laticrete International, Inc.**]
    c. [**Master Builders Solutions**]

C. Emery Dry-Shake Floor Hardener: [**Pigmented**][**Unpigmented**], factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

1. Color: [**As indicated by manufacturer's designation**][**As directed by the Owner**].

D. Metallic Dry-Shake Floor Hardener: [**Pigmented**][**Unpigmented**], factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

1. Color: **[As indicated by manufacturer's designation][As directed by the Owner].**

E. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Dayton Superior Corporation**]
    b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    c. [**Kaufman Products, Inc**]
    d. [**Laticrete International, Inc.**]
    e. [**Master Builders Solutions**]
    f. [**Metalcrete Industries**]
    g. [**SpecChem, LLC**]
    h. [**US MIX Co.**]

F. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**Butterfield Color, Inc.**]
c. [**Dynamic Color Solutions, Inc**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Master Builders Solutions**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**SpecChem, LLC**]

2. Color: **[As indicated by manufacturer's designation][As directed by the Owner].**

2.7 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SIMIRON Inc.**]
b. [**Bone Dry Products, Inc.**]
c. [**ChemMasters, Inc**]
d. [**ChemTec International**]
e. [**Concrete Sealers USA**]
f. [**Curecrete Distribution Inc.**]
g. [**Dayton Superior Corporation**]
h. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
i. [**HTS Chemical; Hi-Tech Systems**]
j. [**Kaufman Products, Inc**]
k. [**Laticrete International, Inc.**]
l. [**MAPEI Corporation**]
m. [**Master Builders Solutions**]
n. [**NewLook International, Inc.**]
o. [**Nox-Crete Products Group**]
p. [**Penetron USA, Inc.**]
q. [**PROSOCO, Inc**]

r. [**SINAK**]
s. [**Solomon Colors Inc.**]
t. [**SpecChem, LLC**]
u. [**Specialty Products Group**]
v. [**US SPEC, Division of US MIX Company**]
w. [**V-Seal Concrete Sealers & Specialty Coatings**]
x. [**Vexcon Chemicals Inc.**]
y. [**W. R. Meadows, Inc**]

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Master Builders Solutions**]
k. [**Metalcrete Industries**]
l. [**Nox-Crete Products Group**]
m. [**Sika Corporation**]
n. [**SINAK**]
o. [**SpecChem, LLC**]
p. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
q. [**Vexcon Chemicals Inc.**]
r. [**W. R. Meadows, Inc**]

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq. m)** when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 deg F (10 deg C): Black.
b. Ambient Temperature between 50 and 85 deg F (10 and 29 deg C): Any color.
c. Ambient Temperature Above 85 deg F (29 deg C): White.

D. Curing Paper: **8 ft. (2438 mm)** wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]

E. Water: Potable water that does not cause staining of the surface.

F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Nox-Crete Products Group**]
j. [**SpecChem, LLC**]
k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
l. [**Vexcon Chemicals Inc.**]
m. [**W. R. Meadows, Inc**]

G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]

d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Master Builders Solutions**]
i. [**Metalcrete Industries**]
j. [**Nox-Crete Products Group**]
k. [**PROSOCO, Inc**]
l. [**SpecChem, LLC**]
m. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
n. [**Vexcon Chemicals Inc.**]
o. [**W. R. Meadows, Inc**]

H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**Lambert Corporation**]
f. [**Laticrete International, Inc.**]
g. [**Master Builders Solutions**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**SpecChem, LLC**]
k. [**V-Seal Concrete Sealers & Specialty Coatings**]
l. [**Vexcon Chemicals Inc.**]
m. [**W. R. Meadows, Inc**]

I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Master Builders Solutions**]

j. [**Metalcrete Industries**]
k. [**Nox-Crete Products Group**]
l. [**PROSOCO, Inc**]
m. [**Right Pointe**]
n. [**SpecChem, LLC**]
o. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
p. [**Vexcon Chemicals Inc.**]
q. [**W. R. Meadows, Inc**]

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Metalcrete Industries**]
j. [**Nox-Crete Products Group**]
k. [**Right Pointe**]
l. [**SINAK**]
m. [**SpecChem, LLC**]
n. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
o. [**Vexcon Chemicals Inc.**]
p. [**W. R. Meadows, Inc**]

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.9 ACCESSORIES

A. Expansion- and Isolation-Joint-Filler Strips: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**or**][**ASTM D1752, cork or self-expanding cork**].

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, [**epoxy resin with a Type A shore durometer hardness of 80**][**aromatic polyurea with a Type A shore durometer hardness range of 90 to 95**] in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. [**Types I and II, nonload bearing**][**Types IV and V, load bearing**], for bonding hardened or freshly mixed concrete to hardened concrete.

E. Floor Slab Protective Covering: **8 ft. (2438 mm)** wide cellulose fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**McTech Group, Inc.**]

2.10 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/8 inch (3 mm)** and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)** or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than [**4100 psi (29 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/4 inch (6 mm)** and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)** or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than [**5000 psi (34.5 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

2.11 CONCRETE MIXTURE MATERIALS

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with **ACI 301 (ACI 301M)**.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
2. Use permeability-reducing admixture in concrete mixtures where indicated.

D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.12 CONCRETE MIXTURE CLASS TYPES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1-1/2 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1-1/2 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1-1/2 inches (40 mm)**][**30 inches (762 mm), plus or minus 2-1/2 inches (65 mm)**].
6. Air Content:

    a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm)**

nominal maximum aggregate size][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cementitious materials.
8. Compressive strength or alternative methods of estimating in-place strength of concrete by maturity or other nondestructive testing with acceptable correlation between test results and concrete compressive strength.

B. Class B: Normal-weight concrete used for foundation walls.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

   b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.
8. Compressive strength or alternative methods of estimating in-place strength of concrete by maturity or other nondestructive testing with acceptable correlation between test results and concrete compressive strength.

C. Class C: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi**

(27.6 MPa)][3500 psi (24.1 MPa)][3000 psi (20.7 MPa)][**As indicated**] at [**28**][**56**][**90**] days.

3. Maximum w/cm Ratio : [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

    a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.
8. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (29.7 kg/cu. m)**].
9. Synthetic Microfiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**].
10. Synthetic Macrofiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**4.0 lb/cu. yd. (2.4 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

D. Class D: Normal-weight concrete used for interior suspended slabs.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

    a. Total air content must not exceed 3 percent for concrete used in trowel-finished floors.

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.
8. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (29.7 kg/cu. m)**].
9. Synthetic Microfiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**].
10. Synthetic Macrofiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**4.0 lb/cu. yd. (2.4 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

E. Class E: Structural lightweight concrete used for interior suspended slabs.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Equilibrium Density: **115 lb/cu. ft. (1842 kg/cu. m)**, plus or minus **4 lb/cu. ft. (48.1 kg/cu. m)** in

accordance with ASTM C567/C567M.

4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

    a. Total air content must not to exceed 3 percent for concrete used in trowel-finished floors.

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.
8. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (29.7 kg/cu. m)**].
9. Synthetic Microfiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**].
10. Synthetic Macrofiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**4.0 lb/cu. yd. (2.4 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

F. Class F: Normal-weight concrete used for concrete toppings.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**]at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.

    a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].
    b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

5. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

    a. Total air content must not to exceed 3 percent for concrete used in trowel-finished floors.

6. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (29.7 kg/cu. m)**]
7. Synthetic Microfiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**].
8. Synthetic Macrofiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**4.0 lb/cu. yd. (2.4 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

G. Class G: Normal-weight concrete used for building frame members.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

    a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

    b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

H. Class H: Normal-weight concrete used for building walls.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

    a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

    b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete**

containing 1-inch (25-mm) nominal maximum aggregate size][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

I. Class I: Normal-weight concrete used for interior metal pan stairs and landings:

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**3000 psi (20.7 MPa)**][**As indicated**] at 28 days.
3. Maximum w/cm Ratio: [**0.53**][**0.45**][**0.40**].
4. Maximum Size Aggregate: **1/2 inch (13 mm)**.
5. Slump Limit: **3 inches (75 mm)**, plus **1 inch (25 mm)** or minus **2 inches (50 mm)**.
6. Air Content: [**0**] percent, plus or minus 1.5 percent at point of delivery.
7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

J. Class J: Normal-weight concrete used for exterior retaining walls.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

   b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish delivery ticket.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 TOLERANCES

A. Comply with **ACI 117 (ACI 117M)**.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install reglets to receive waterproofing and through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.5 INSTALLATION OF VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than **6 inches (150 mm)**, sealing vapor retarder to concrete.
4. Lap joints **6 inches (150 mm)** and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by **6 inches (150 mm)** on all sides and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.6 INSTALLATION OF CAST-IN-PLACE CONCRETE

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. As directed by the Owner, notify the Owner and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Water addition in transit or at the Project site must be in accordance with ASTM C94/C94M and must not exceed the permitted amount indicated on the concrete delivery ticket.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with **ACI 301 (ACI 301M)**.

    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least **6 inches (150 mm)** into preceding layer.
    c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 INSTALLATION OF JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings as directed by the Owner.
2. Place joints perpendicular to main reinforcement.

    a. Continue reinforcement across construction joints unless otherwise indicated.

3. Form keyed joints as indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls [**as indicated on Drawings**]. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least [**one-fourth**] of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of **1/8 inch (3 mm)**. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch (3-mm-)** wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.8 APPLICATION OF FINISHING FLOORS AND SLABS

A. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of **1/4 inch (6 mm)** in one direction.
3. Apply scratch finish to surfaces [**to receive concrete floor toppings**][**to receive mortar setting beds for bonded cementitious floor finishes**].

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with **ACI 117 (ACI A117M)** tolerances for conventional concrete.
3. Apply float finish to surfaces [**to receive trowel finish**][**and**][**to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo**].

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface. Use of an approved finishing aid is acceptable.
5. Do not apply troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces [**exposed to view**][**or**][**to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system**].
7. Finish surfaces to the following tolerances, in accordance with **ASTM E1155 (ASTM E1155M)**, for a randomly trafficked floor surface:

    a. Slabs on Ground:

        1) Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.

2) Specified overall values of flatness, FF 35; and of levelness, FL 25; with minimum local values of flatness, FF 24; and of levelness, FL 17.
3) Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.
4) Specified overall values of flatness, FF 50; and of levelness, FL 35; with minimum local values of flatness, FF 40; and of levelness, FL 24.

b. Suspended Slabs:

1) Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.
2) Specified overall values of flatness, FF 35; and of levelness, FL 20; with minimum local values of flatness, FF 24; and of levelness, FL 15.
3) Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.

D. Trowel and Fine-Broom Finish: First apply a trowel finish to surfaces [**indicated on Drawings**][**where ceramic or quarry tile is to be installed by either thickset or thinset method**]. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish as directed by the Owner before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish as directed by the Owner before application.

F. Slip-Resistive Finish: Before final floating, apply slip-resistive [**aggregate**][**aluminum granule**] finish to concrete stair treads, platforms, and ramps, as indicated on Drawings.

1. Apply in accordance with manufacturer's written instructions and as follows:

a. Uniformly spread [**25 lb/100 sq. ft. (12 kg/10 sq. m)**] of dampened slip-resistive [**aggregate**][**aluminum granules**] over surface in one or two applications.
b. Tamp aggregate flush with surface, but do not force below surface.
c. After broadcasting and tamping, apply float finish.
d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive [**aggregate**][**aluminum granules**].

G. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**] unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating.
3. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
4. After final floating, apply a trowel finish.
5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.9 APPLICATION OF FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

   a. Patch voids larger than **1-1/2 inches (38 mm)** wide or **1/2 inch (13 mm)** deep.
   b. Remove projections larger than **1 inch (25 mm)**.
   c. Tie holes do not require patching.
   d. Surface Tolerance: **ACI 117 (ACI 117M)**, Class D.
   e. Apply to concrete surfaces for metal lap pan deck formed surfaces and those surfaces that are buried or covered with subsequent installed surfaces.

2. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

   a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
   b. Remove projections larger than **1/4 inch (6 mm)**.
   c. Patch tie holes.
   d. Surface Tolerance: **ACI 117 (ACI 117M)**, Class B.
   e. Locations: Apply to concrete surfaces [**exposed to public view,**][**to receive a rubbed finish,**][**or to be covered with a coating or covering material applied directly to concrete**].

3. ACI 301 (ACI 301M) Surface Finish SF-3.0:

   a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
   b. Remove projections larger than **1/8 inch (3 mm)**.
   c. Patch tie holes.
   d. Surface Tolerance: **ACI 117 (ACI 117M)** Class A.
   e. Locations: Apply to concrete surfaces [**exposed to public view,**][**to receive a rubbed finish,**][**or to be covered with a coating or covering material applied directly to concrete**].

B. Rubbed Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:

   a. Perform no later than one day after form removal.
   b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
   c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
   d. Maintain required patterns or variances as shown on Drawings or to match [**design reference sample**][**field sample panels**][**mockups**].

2. Grout-Cleaned Rubbed Finish:

   a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
   b. Do not clean concrete surfaces as Work progresses.
   c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
   d. Wet concrete surfaces.

e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
f. Maintain required patterns or variances as shown on Drawings or to match [**design reference sample**][**field sample panels**][**mockups**].

C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform abrasive blasting after compressive strength of concrete exceeds **2000 psi (13.8 MPa)**.
2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
3. Surface Continuity:

a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
b. Maintain required patterns or variances in depths of blast to match [**design reference sample**][**field sample panels**][**mockups**].

4. Abrasive Blasting:

a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
b. Determine type of nozzle pressure and blasting techniques required to match field sample.
c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:

1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.
2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of **1/16 inch (1.5 mm)**.
3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of **1/4 inch (6 mm)**.
4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of **1/4 to 1/2 inch (6 to 13 mm)**.

d. Maintain required patterns or variances in reveal projection to match [**design reference sample**][**field sample panels**][**mockups**].

D. High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of **4500 psi (31 MPa)**.
2. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
3. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
4. Maintain required patterns or variances in reveal projection to match [**design reference sample**][**field sample panels**][**mockups**].

E. Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform bushhammer finish to concrete that has achieved a minimum compressive strength of **4500 psi (31 MPa)**.
2. Surface Continuity:

a. Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.

3. Surface Cut:

a. Maintain required depth of cut and general aggregate exposure.
b. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.

4. Remove impressions of formwork and form facings with exception of tie holes.
5. Maintain required patterns or variances of cut as shown on Drawings or to match [**design reference sample**][**field sample panels**][**mockups**].
6. Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, windbreaks, or similar devices.

3.10 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling in:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**] high unless otherwise indicated on Drawings, and extend base not less than **6 inches (150 mm)** in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**] at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.

a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
b. Cast anchor-bolt insert into bases.
c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.11 APPLICATION OF CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with **ACI 301 (ACI 301M)** for cold weather protection during curing.
2. Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)** for hot-weather protection during curing.
3. Maintain moisture loss no more than **0.2 lb/sq. ft. x h (1 kg/sq. m x h)**, calculated in accordance with ACI 305R, before and during finishing operations.

B. Curing Formed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period as follows:

a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
b. Continuous Sprinkling: Maintain concrete surface continuously wet.
c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

1) Recoat areas subject to heavy rainfall within three hours after initial application.
2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:

1. Begin curing after finishing concrete.
2. Interior Concrete Floors:

a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than **12 inches (300 mm)**.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following not in cold weather:

a) Water.
b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than **12 inches (300 mm)**.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

c. Floors to Receive Polished Finish: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than **12 inches (300 mm)**.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

d. Floors To Receive Chemical Stain:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.

3) Butt sides of curing paper tight; do not overlap sides of curing paper.
4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors To Receive Urethane Flooring:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped **6 inches (150 mm)** and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors To Receive Curing Compound:

1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

g. Floors To Receive Curing and Sealing Compound:

1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than [**three**][**seven**][**14**][**28**] days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface has received a float finish or abrasive surface preparation.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.13 INSTALLATION OF JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least [**one**][**six**] month(s).

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least **2 inches (50 mm)** deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.14 INSTALLATION OF CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas as directed by the Owner.
2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a **No. 16 (1.18-mm)** sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks in excess of **0.01 inch (0.25 mm)** spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than **1/2 inch (13 mm)** in any dimension to solid concrete.

    a. Limit cut depth to **3/4 inch (19 mm)**.
    b. Make edges of cuts perpendicular to concrete surface.
    c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    d. Fill and compact with patching mortar before bonding agent has dried.
    e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

    a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    b. Compact mortar in place and match surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as directed by the Owner.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

    a. Correct low and high areas.
    b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of **0.01 inch (0.25 mm)** wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.

    a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

    a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

    a. Cut out low areas to ensure a minimum repair topping depth of **1/4 inch (6 mm)** to match adjacent floor elevations.
    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes **1 inch (25 mm)** or less in diameter, by cutting out and replacing with fresh concrete.

    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a **3/4-inch (19-mm)** clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes **1 inch (25 mm)** or less in diameter with patching mortar.

    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, as directed by the Owner, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, as directed by the Owner.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: [**the Owner**][**Engage**] a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31/C31M.
2. Testing agency to immediately report to The Owner and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, the Owner within 48 hours of inspections and tests, as directed by the Owner.

    a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and **ACI 301 (ACI 301M)**, including the following as applicable to each test and inspection:

        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results of fresh concrete, including slump or slump flow, air content, temperature and density.
        13) Information on storage and curing of samples at the Project site, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

4. Provide a space and source of power or other resources for curing and access to test specimens by the testing agency.

C. Delivery Tickets: comply with ASTM C94/C94M.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as directed by the Owner.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding **5 cu. yd. (4 cu. m)**, but less than **25 cu. yd. (19 cu. m)**, plus one set for each additional 1**50 cu. yd. (114 cu. m)** or fraction thereof.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
b. Perform additional tests as needed.

3. Slump Flow: ASTM C1611/C1611M:

a. One test at point of delivery for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.
b. Perform additional tests as needed.

4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; [**ASTM C173/C173M volumetric method, for structural lightweight concrete**].

a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064/C1064M:

a. One test hourly when air temperature is **40 deg F (4.4 deg C)** and below or **80 deg F (27 deg C)** and above, and one test for each composite sample when strength test specimens are cast.

6. Concrete Density: ASTM C138/C138M:

a. One test for each composite sample when strength test specimens are cast.

7. Unit Weight: ASTM C138/C138M density of fresh structural lightweight concrete.

a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture. The fresh density should be consistent with that associated with the equilibrium density within a tolerance of plus or minus 4 lb/ft.3.

8. Compression Test Specimens: ASTM C31/C31M:

a. Cast and standard cure two sets of [**two**][**three**][**four**] **6 inches (150 mm)** by **12-inches (300 mm)** or **4-inch (100-mm)** by **8-inch (200-mm)** cylindrical specimens for each composite sample.
b. Cast, and field cure [**two**] sets of [**two**][**three**][**four**] standard cylindrical specimens for each composite sample.

9. Compressive-Strength Tests: ASTM C39/C39M.

a. Test one set of [**two**][**three**][**four**] standard cured specimens at seven days and one set of two specimens at 28 [**other age**] days.
b. Test one set of [**two**][**three**][**four**] field-cured specimens at seven days and one set of two specimens at 28 days.
c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

10. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
11. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by

more than **500 psi (3.4 MPa)** if specified compressive strength is **5000 psi (34.5 MPa)**, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than **5000 psi (34.5 MPa)**.

12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests:

    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by the Owner.

        1) Acceptance criteria for concrete strength to be in accordance with **ACI 301 (ACI 301M)**, Section 1.7.6.3.

14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with **ASTM E1155 (ASTM E1155M)** within [**24**][**48**][**72**] hours of completion of floor finishing and promptly report test results, as directed by the Owner.

3.16 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using floor slab protective covering.

END OF SECTION 03 30 00 00

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Task	Specification	Specification Description
03 30 53 00	03 30 00 00	Cast-In-Place Concrete
03 31 00 00	03 30 00 00	Cast-In-Place Concrete
03 31 13 00	03 30 00 00	Cast-In-Place Concrete
03 31 13 00	32 13 13 00	Concrete Paving
03 31 13 00	32 13 16 00	Decorative Concrete Paving
03 31 16 00	03 30 00 00	Cast-In-Place Concrete
03 35 00 00	03 30 00 00	Cast-In-Place Concrete
03 35 13 00	03 30 00 00	Cast-In-Place Concrete
03 35 16 00	03 30 00 00	Cast-In-Place Concrete
03 35 19 00	03 30 00 00	Cast-In-Place Concrete
03 35 23 00	03 30 00 00	Cast-In-Place Concrete
03 35 26 00	03 30 00 00	Cast-In-Place Concrete
03 35 29 00	03 30 00 00	Cast-In-Place Concrete
03 35 33 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 35 43 00 - POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stain materials.
2. Liquid floor treatments.
3. Polished concrete surface finish requirements.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for new concrete designed for polished concrete finishing, including concrete materials, mixture design, placement procedures, initial finishing, and curing.

1.2 DEFINITIONS

A. Aggregate Exposure Class: Visual observation of polished floor aggregate surface exposure area after grinding and polishing operations. Aggregate exposure class ranges are A, B, and C.

B. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.

C. Distinctness of Image (DOI): The distinctness (clarity) of images reflected by the glossy coating surface appearance of the polished concrete finish appearance levels. The transmission of this reflection is measured in accordance with ASTM D5767.

D. Haze: The cloudiness or milky appearance of images from objects produced by reflection in a polished concrete surface. The measurement of this appearance is defined in accordance with ASTM D4039. The test method reading is put into a calculation resulting in a Haze Index value.

E. Specular Gloss: A reflectance value determined by a single measurement of gloss from shining a known amount of light at a surface within a specific angle of illumination in accordance with ASTM D523.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with polished concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place concrete subcontractor.
e. Polished concrete finishing subcontractor.

f. Architect.
g. The Owner.

2. Review [**concrete slab design for compressive strength, flatness and levelness,**][**cold- and hot-weather concreting procedures,**][**curing procedures,**][**sequencing,**][**construction joints,**][**concrete repair procedures,**][**concrete finishing,**] polished concrete appearance and aggregate exposure requirements, polished concrete mockups, and protection of polished concrete.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Laboratory Test Reports: For [**stains**][**and**][**liquid floor treatments**], indicating compliance with requirements for low-emitting materials.

C. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of product requiring color selection.

E. Samples for Verification: Actual sample of finished products for each type of exposed color.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. An installer experienced in performing polished concrete finishing with a minimum of five previous projects similar in material, design, and extent to that indicated for this Project.
2. Trained and certified by manufacturer of polished concrete system materials.
3. Concrete Polishing Craftsman of the Concrete Polishing Council.

B. Polished Concrete Standards: Comply with ACI 310.1.

1.6 MOCKUPS

A. Build mockups [**10 by 10 ft (3.05 by 3.05 m)**]to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location of the Work and of the size indicated or, if not indicated, as directed by the Owner for [**newly placed**][**existing**] concrete.
2. Demonstrate surface preparation, [**coloring,**][**pattern,**][**curing,**] tested aggregate exposure, tested polish appearance, sealing and protecting of polished concrete.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
4. Remove rejected mockups.

1.7 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as needed for other construction activities.

B. Ambient Conditions: Ensure installation location and Project ambient conditions comply with manufacturers written instructions.

PART 2 - PRODUCTS

2.1 STAIN MATERIALS

A. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**EPMAR Corporation; a Quaker Houghton company**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**QC Construction Products**]
k. [**Scofield, a Business Unit of Sika Corporation**]
l. [**Specialty Concrete Products, Inc**]
m. [**Stampcrete International, Ltd**]
n. [**Super Stone, Inc.**]
o. [**SureCrete Design Products, a Fenix Group SPC Company**]

B. Penetrating Stain: Coloring agents used to add consistent color to polished concrete surfaces without coloring the aggregates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**AmeriPolish**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Duckback Products**]

h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**Super Stone, Inc.**]

C. VOC Content: For field applications[**that are inside the weatherproofing system**], verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Primers, Sealers, and Undercoaters: 100 g/L.
2. Clear Wood Finishes, Varnishes: 275 g/L.
3. Clear Wood Finishes, Lacquers: 275 g/L.
4. Shellacs, Clear: 730 g/L.
5. Stains: 100 g/L.

D. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Verify not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

F. VOC Emissions: For field applications inside the building, verify wall paints contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.2 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear liquid materials for the applications of cleaning solutions, densifiers, and sealers that strengthen or protect polished concrete surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Floor Products**]
b. [**AmeriPolish**]
c. [**ARDEX Americas**]
d. [**AWRC Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]

i. [**Moxie International**]
j. [**NewLook International, Inc.**]
k. [**Nox-Crete Products Group**]
l. [**PROSOCO, Inc**]
m. [**QuestMark**]
n. [**Vexcon Chemicals Inc.**]

2. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 POLISHED CONCRETE SURFACE FINISH REQUIREMENTS

A. Aggregate Exposure Class: [**Class A Cement Fines 85 to 95 percent fines; 5 to 15 percent fine aggregate**][**Class B Fine Aggregate 85 to 95 percent fine aggregate; 5 to 15 percent blend of fines and coarse aggregate**][**Class C Coarse Aggregate 10 to 20 percent cement fines and fine aggregates**].

B. Polish Concrete Appearance Levels: [**Level 1: Flat (Ground) up to 100-grit polish; DOI 0 to 9; Haze Reading less than 10**][**Level 2: Satin (Honed) up to 200- to 400-grit polish; DOI 10 to 39; Haze Reading less than 10; Reflective Sheen: Low to medium**][**Level 3: Polished (Polished Gloss up to 400- to 800-grit polish; DOI 40 to 69; Haze Reading less than 10; Reflective Sheen: Medium to high**][**Level 4: Highly Polished (Very High Gloss) 800-grit and higher polish; DOI 70 to 100; Haze Reading less than 10; Reflective Sheen: High to highest**][**Match design reference sample**].

C. Slip Resistance: Minimum Dynamic Coefficient of Friction (DCOF) of 0.42. Provide required slip resistance based on final gloss level and determined by the Concrete Polishing Council.

2.4 ACCESSORIES

A. Repair Materials: As recommended in writing by manufacturer to repair and fill cracks, and repair surfaces compatible with polishing materials.

B. Water: Potable.

C. Cleaning Agents: As recommended in writing by manufacturer.

2.5 POLISHING EQUIPMENT

A. Equipment and Supplies: Provide equipment and supplies, not limited to, the concrete grinding and concrete polisher equipment, tooling and polishing diamonds for the polished concrete finishing Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that concrete substrates are acceptable for grinding, polishing and product installation as recommended by manufacturer.

B. Do not begin Work until unsatisfactory conditions have been addressed and corrected.

3.2 PREPARATION

A. Verify that concrete substrate preparation is in accordance with manufacturer's written instructions.

B. Clean surfaces free of dust, dirt and other contaminates incompatible with liquids applied products and polishing.

C. Clean and seal cracks as recommended by manufacturer.

D. Prepare, clean and fill joints with joint filler as recommended in writing by manufacturer.

E. Clean surface completely of any dust with cleaning solution as recommended in writing by manufacturer.

3.3 APPLICATION

A. Machine grind floor surfaces progressively to receive aggregate and polish appearance levels indicated to match approved mockup.

B. Scoring: Score decorative jointing in concrete surfaces **1/16 inch (1.6 mm)** deep with diamond blades to match pattern indicated. Rinse until water is clear. Score [**after**][**before**] staining.

1. Joint Width: [**3/8 inch (10 mm)**].

C. Apply penetrating stain densifier treatment for polished concrete in polishing sequence and in accordance with manufacturer's written instructions, allowing recommended drying time between successive coats.

D. Apply reactive color stain for polished concrete in polishing sequence and in accordance with manufacturer's written instructions.

E. Apply color dyes for polished concrete in polishing sequence and in accordance with manufacturer's written instructions.

F. Apply sealers to polished concrete in polishing sequence and in accordance with manufacturers' written instructions.

G. Continue progressively polishing to aggregate and polish appearance levels to match approved mockup for final finish appearance.

H. Visually inspect to remove defects and repolish areas that are defective. Repolish those areas that do not meet specified aggregate and polish levels per approved mockup.

I. Complete edges of floor finish that adjoins surrounding floor areas in a sharp and clean manner.

J. Neutralize and clean polished floor surfaces.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner**][**Engage**] a qualified testing and inspecting agency to perform tests at three random locations for areas up to **100 sq. ft.** **(465 sq. m)** and inspections and to submit reports.

B. Measure polish specular gloss level, DOI, and haze as specified; repolish if required to achieve Project requirements.

C. Verify aggregate exposure as specified. Machine surfaces if required to achieve Project requirements.

D. Verify compliance of slip resistance to comply with specified slip-resistance rating.

E. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Control and dispose of waste products produced by grinding and polishing operations.

B. Protect installed polished concrete surfaces from damage during construction in accordance with manufacturer's written instructions.

END OF SECTION 03 35 43 00

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Task	Specification	Specification Description
03 35 43 00	03 30 00 00	Cast-In-Place Concrete
03 35 63 00	03 30 00 00	Cast-In-Place Concrete
03 35 66 00	03 30 00 00	Cast-In-Place Concrete
03 35 83 00	03 30 00 00	Cast-In-Place Concrete
03 37 00 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 37 13 00 - SHOTCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dry-mix shotcrete.
2. Wet-mix shotcrete.

1.2 DEFINITIONS

A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.

B. Dry-Mix Shotcrete: Shotcrete with most of the mixing water added at nozzle.

C. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Require representatives of each entity directly concerned with shotcrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for shotcrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Shotcrete Installer.

2. Review methods and procedures related to shotcrete, but not limited to, the following:

a. Qualification data, equipment, and facilities needed to make progress and avoid delays.
b. Shotcrete finishes and finishing.
c. Cold- and hot-weather shotcreting procedures.
d. Curing procedures
e. Construction joints.
f. Forms and form-removal limitations.
g. Reinforcement accessory installation.
h. Shotcrete repair procedures.
i. Protection of shotcrete.

3. Before submitting design mixtures, review each shotcrete design mixture and examine procedures for ensuring quality of shotcrete materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Design Mixtures: For each shotcrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. For predampened dry-mix mixtures, indicate amounts of mixing water to be added to the dry-mix materials before mixing and conveying through the delivery hose.

D. Shop Drawings: For shotcrete installation.

1. Include plans, elevations, sections, and support and anchor details.
2. Detail fabrication, bending, and placing of reinforcement; number and location of splices; and special reinforcement required for openings through shotcrete structures.
3. Detail formwork fabrication, assembly, and support.
4. Indicate locations of proposed construction joints.

E. Samples: For [**waterstops, approximately 24 inches (600 mm) long**][**and**][**each exposed product and for each color and finish specified, approximately 24 by 24 by 2 inches (600 by 600 by 50 mm) in size**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**testing agency**][**and**][**preconstruction testing service**].

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Form materials.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.

C. Preconstruction Test Reports: For shotcrete.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer employing nozzle operators for Project, each of whom [**attains mean core grades not exceeding 2.5, according to ACI 506.2, on preconstruction tests**][**is**

ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical Position][**is ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical and Overhead Positions**][**is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical Position**][**and**][**is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical and Overhead Positions**] as appropriate to the required shotcrete work.

B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

C. Standard: Comply with ACI 506.2, "Specification for Shotcrete," unless otherwise indicated.

D. Shotcrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design shotcrete mixtures.

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution, as directed by the Owner.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner**][**Engage**] a qualified testing agency to perform preconstruction testing on shotcrete.

1. Produce and test shotcrete test panels before shotcrete placement according to requirements in ACI 506.2 for each design mixture, shooting orientation, and nozzle operator. Produce test panels with dimensions of **24 by 24 inches (600 by 600 mm)** minimum and of average thickness of shotcrete, but not less than **3-1/2 inches (90 mm)**.
2. From each test panel, testing agency to obtain six test specimens: one set of three specimens unreinforced, and one set of three specimens reinforced. Agency will perform the following:

    a. Strength Testing: Test each set of unreinforced specimens for compressive strength according to ASTM C42/C42M.
    b. Core Grading: Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.[**Avoid damaging coatings on steel reinforcement.**]

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms: Form-facing panels that will provide continuous, straight, smooth, concrete surfaces. Furnish panels in largest practical sizes to minimize number of joints.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Galvanized Reinforcing Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, ASTM A767/A767M, [**Class I**][**Class II**] zinc coated after fabrication and bending.

D. Plain-Steel Wire: ASTM A1064/A1064M, [**as drawn**][**galvanized**].

E. Welded Wire Reinforcement: ASTM A1064/A1064M, [**plain, fabricated from as-drawn steel wire**][**plain, fabricated from galvanized-steel wire**][**deformed**], furnished in flat sheet.

F. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place; manufactured according to CRSI's "Manual of Standard Practice" and as follows:

1. For uncoated reinforcement, use [**all-plastic**][**CRSI Class 1, plastic-protected**][**or**][**CRSI Class 2, stainless steel**] bar supports.
2. For zinc-coated reinforcement, use [**galvanized wire or dielectric-polymer-coated wire**][**or**][**all-plastic**] bar supports.

G. Reinforcing Anchors: ASTM A36/A36M, unheaded rods or ASTM A307, Grade A, hex-head bolts; carbon steel; and carbon-steel nuts.

1. Finish: [**Plain, uncoated**][**Hot-dip zinc coating, ASTM A153/A153M**].

H. Zinc Repair Material: ASTM A780/A780M, zinc-based solder, paint containing zinc dust, or sprayed zinc.

2.3 SHOTCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, [**Type I**][**or**][**Type III**]. Use only one brand and type of cement for Project.

1. Fly Ash: ASTM C618, Class C or Class F.
2. Slag Cement: ASTM C989/C989M, Grade 100 or Grade 120.
3. Silica Fume: ASTM C1240, amorphous silica.

B. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, portland-pozzolan**][**Type IL, portland-limestone**][**Type IT, ternary blended**] cement.

C. Normal-Weight Aggregates: ASTM C33/C33M, from a single source, and as follows:

1. Combined Aggregate Size: ACI 506R or ASTM C1436, Grading [**No. 1**][**No. 2**] sieve analysis.
2. Deleterious Substances: As specified for [**fine aggregate**][**coarse-aggregate Class 3S**][**coarse-aggregate Class 3M**][**coarse-aggregate Class 1N**] according to ASTM C33/C33M.

D. Lightweight Aggregates: ASTM C330/C330M.

1. Combined Aggregate Size: ACI 506R, Grading [**No. 1**][**No. 2**] sieve analysis.

E. Water: Potable, complying with ASTM C94/C94M, and free from deleterious materials that may affect color stability, setting, or strength of shotcrete.

F. Carbon-Steel Fiber: ASTM A820/A820M, [**Type I, cold-drawn wire**][**or**][**Type II, cut sheet**], deformed.

1. Nominal Length: [**0.5 inch (13 mm)**][**1 inch (25 mm)**][**1.5 inches (38 mm)**].
2. Aspect Ratio: [**35 to 40**][**45 to 50**][**60 to 65**].

G. Synthetic Fiber: [**Monofilament**][**or**][**fibrillated**] polypropylene fibers engineered and designed for use in shotcrete, complying with ASTM C1116/C1116M, Type III, [**1 to 1.5 inches (25 to 38 mm)**][**1.5 to 2 inches (38 to 50 mm)**] long.

H. Ground Wire: High-strength steel wire, 0.8 to 1.0 mm in diameter.

I. Joint Filler Strips: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**or**][**ASTM D1752, cork or self-expanding cork**].

J. Admixtures: ASTM C1141/C1141M, Class A (liquid) or Class B (nonliquid), but limited to the following admixture materials. Provide admixtures for shotcrete that contain no more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.

1. Accelerating Admixture, Conventional: ASTM C494/C494M, Type C or Type E.
2. Pozzolanic Admixture: Fly ash, slag cement, and silica fume as limited in "Portland Cement" Paragraph in this article.
3. Coloring Admixture: ASTM C979/C979M, synthetic mineral-oxide pigment or colored, water-reducing admixture, free of carbon black; color stable, nonfading, and resistant to lime and other alkalis.
4. Air-Entraining Admixture: As limited in "Shotcrete Mixtures" Article.

2.4 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Profile: [**Flat dumbbell without center bulb**][**Ribbed without center bulb**][**As indicated**].
2. Dimensions: [**4 inches by 3/16 inch thick (100 mm by 4.75 mm thick)**]; nontapered.

B. Flexible PVC Waterstops: CE CRD-C 572,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Profile: [**Flat dumbbell without center bulb**][**Ribbed without center bulb**][**As indicated**].
2. Dimensions: [**4 inches by 3/16 inch thick (100 mm by 4.75 mm thick)**]nontapered.

C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, **3/4 by 1 inch (19 by 25 mm)**.

D. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free, hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete; **3/8 by 3/4 inch (10 by 19 mm)**.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq. m)** dry, or cotton mats.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Curing Compound: ASTM C309, Type 1, Class B; clear, [**waterborne**][**solvent-borne**], membrane-forming curing compound.

2.6 SHOTCRETE MIXTURES

A. Source Limitations for Shotcrete: Obtain each color, size, type, and variety of shotcrete material and shotcrete mixture from single manufacturer with resources to provide shotcrete of consistent quality in appearance and physical properties.

B. Design Mixtures: Prepare design mixtures for each type and strength of shotcrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 506.2.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixture or field test data, or both.

C. Cementitious Materials Replacing Portland Cement: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

D. Cementitious Materials, Maximum Content: Limit use of [**fly ash**][**slag cement**][**and**][**silica fume**] to not exceed, in combination, [**25**] percent of portland cement by weight.

E. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by **ACI 301 (ACI 301M)**.

F. Admixtures: Use admixtures according to manufacturer's written instructions.

G. Coloring Admixture: Add coloring admixture to shotcrete mixture according to manufacturer's written instructions and to result in hardened shotcrete color consistent with approved mockup.

H. Design-Mixture Adjustments: Subject to compliance with requirements, shotcrete design-mixture adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

I. Shotcrete Mixture: Proportion mixture to provide shotcrete with the following properties:

1. Compressive Strength (28 Days): [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**].
2. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight wet-mix shotcrete having an air content before pumping of [**7**][**8**] percent with a tolerance of plus or minus 1-1/2 percent.
3. Carbon-Steel Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (30 kg/cu. m)**][**100 lb/cu. yd. (60 kg/cu. m)**].
4. Synthetic Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written

instructions, at a rate of [**1.5 lb/cu. yd. (0.90 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

5. Color: [**As indicated by manufacturer's designation**][**as directed by the Owner**].
6. Color of [**Flash**][**Finish**] Coat: [**As indicated by manufacturer's designation**][**as directed by the Owner**].

2.7 SHOTCRETE EQUIPMENT

A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.

B. Dry-Mix Delivery Equipment: Capable of discharging aggregate-cement mixture into delivery hose under close control and maintaining continuous stream of uniformly mixed materials at required velocity to discharge nozzle. Equip discharge nozzle with manually operated water-injection system for directing even distribution of water to aggregate-cement mixture.

1. Provide uniform, steady supply of clean, compressed air to maintain constant nozzle velocity while simultaneously operating blow pipe for cleaning away rebound.
2. Provide water supply with uniform pressure at discharge nozzle to ensure uniform mixing with aggregate-cement mix. Provide water pump to system if line water pressure is inadequate.

C. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

2.8 BATCHING AND MIXING

A. Dry-Mix Process: Measure mixture proportions by weight batching according to ASTM C94/C94M or by volume batching complying with ASTM C685/C685M requirements.

1. In volume batching, adjust fine-aggregate volume for bulking. Test fine-aggregate moisture content at least once daily to determine extent of bulking.
2. Prepackaged shotcrete materials may be used at Contractor's option. Predampen prepackaged shotcrete materials and mix before use.

B. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C94/C94M[**and ASTM C1116/C1116M**] and furnish batch ticket information.

1. Comply with ASTM C685/C685M when shotcrete ingredients are delivered dry and proportioned and mixed on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Concrete and Masonry Substrates: Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and **1/2 inch (13 mm)** deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces to saturated, surface-dry condition before shotcreting.

1. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.

B. Earth Substrates: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces to saturated, surface-dry condition before shotcreting.

C. Rock Substrates: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding.[**Dampen surfaces to saturated, surface-dry condition before shotcreting.**]

D. Steel Substrates: Clean steel surfaces by abrasive blasting according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3.2 FORMS

A. Design, erect, support, brace, and maintain forms, according to **ACI 301 (ACI 301M)**, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.

1. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
2. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.

B. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.

3.3 STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.

C. Securely embed reinforcing anchors into existing substrates, located as required.

D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports, bolsters, chairs, spacers, and other devices as required to maintain minimum concrete cover.

E. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.

F. Install welded wire reinforcement in largest practical sheets on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A780/A780M. Use galvanized-steel wire ties to fasten zinc-coated steel reinforcement.

3.4 JOINTS

A. General: Construct joints at locations as directed by the Owner.

B. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints unless otherwise indicated.

C. Contraction Joints: Construct contraction joints in shotcrete using saw cuts **1/8-inch- (3-mm-)** wide by one-third of slab depth or joint-filler strips **1/4-inch- (6-mm-)** wide by one-third of shotcrete depth unless otherwise indicated.

1. After shotcrete has cured, remove strip inserts and clean groove of loose debris.
2. Space joints at [**15 feet (4.5 m) o.c.**][**centers indicated**] horizontally and vertically.
3. Tool edges round on each side of strip inserts if floated or troweled finishes are required.
4. Where shooting over an existing substrate joint, align new shotcrete joint with existing joint.

3.5 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

C. Prevent waterstop displacement during shotcrete application.

3.6 ALIGNMENT CONTROL

A. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

3.7 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.8 APPLICATION

A. Apply shotcrete applied by [**dry-mix**][**or**][**wet-mix**] process and according to ACI 506.2.

B. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.

C. Moisten wood forms immediately before placing shotcrete where form coatings are not used.

D. Apply [**dry-mix shotcrete materials within 45 minutes after predampening**][**and**][**wet-mix shotcrete materials within 90 minutes after batching**].

E. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.

1. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
2. Remove and dispose of cuttings during the trimming or rodding process to prevent unconsolidated material from falling onto lower reinforcement.

F. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray, and prevent buildup against front face during shotcreting.

G. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.

H. Do not permit shotcrete to sag, slough, or dislodge.

I. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.

J. Do not disturb shotcrete surfaces before beginning finishing operations.

K. Remove ground wires or other alignment-control devices after shotcrete placement.

L. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.

M. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by **ACI 117 (ACI 117M)**, increased by a factor of two.

N. Cold-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 306.1 and as follows. Protect shotcrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. Discontinue shotcreting when ambient temperature is **40 deg F (4.4 deg C)** and falling.
2. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than **50 deg F (10 deg C)** and no more than **90 deg F (32 deg C)**.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents.

O. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 305.1 when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:

1. Cool ingredients before mixing to maintain, at time of placement, shotcrete temperature below [**100 deg F (38 deg C) for dry mix**][**and**][**90 deg F (32 deg C) for wet mix**].
2. Reduce temperature of reinforcing steel and receiving surfaces below **100 deg F (38 deg C)** before shotcreting.

3.9 SURFACE FINISHES

A. General: Finish shotcrete according to descriptions in ACI 506R.

B. Natural Finishes:

1. Gun Finish: Natural undisturbed finish as sprayed.
2. Rod Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set. Do not push or float with flat part of trowel.
3. Broom Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set; followed by uniform brooming.

C. Flash-Coat Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply up to **1/4-inch (6-mm)** coat of shotcrete using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding **No. 4 (4.75-mm)** sieve to provide a finely textured finish.

D. Flash-Coat with Final Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply up to **1/4-inch (6-mm)** coat of shotcrete using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding **No. 4 (4.75-mm)** sieve, and apply [**wood-float**][**rubber-float**][**brush-float**][**steel-trowel**] finish.

E. Finish-Coat Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply shotcrete finish coat, **1/4 to 1 inch (6 to 25 mm)** thick, using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding **No. 4 (4.75-mm)** sieve to provide a finish of uniform texture and appearance.

F. Finish-Coat with Final Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply shotcrete finish coat, **1/4 to 1 inch (6 to 25 mm)** thick, using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding **No. 4 (4.75-mm)** sieve, and apply [**wood-float**][**rubber-float**][**brush-float**][**steel-trowel**] finish.

3.10 CURING

A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.

B. Begin curing immediately after placing and finishing but not before free water, if any, has disappeared from shotcrete surface.

C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Water-saturated absorptive covers or moisture-retaining covers. Lap and seal sides and ends of covers with **12-inch (300-mm)** lap over adjacent covers.

2. Curing Compound: Apply uniformly in continuous operation by power spray according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Apply curing compound to natural gun and flash-coat finishes at rate of **1 gal./100 sq. ft.**

(1 L/2.5 sq. m).

D. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

3.11 FORM REMOVAL

A. Forms not supporting weight of shotcrete may be removed after curing for 24 consecutive hours at not less than **50 deg F (10 deg C)**, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.

1. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Air Content: ASTM C173/C173M, volumetric method or ASTM C231/C231M, pressure method; one test for each compressive-strength test for each mixture of air-entrained, wet-mix shotcrete measured before pumping.

C. Shotcrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is **40 deg F (4.4 deg C)** and below and when **80 deg F (27 deg C)** and above, and one test for each set of compressive-strength specimens.

D. Test Panels: Make a test panel, reinforced as in structure, for each shotcrete mixture and for each workday or for every [**50 cu. yd. (38 cu. m)**] of shotcrete placed, whichever is less. Produce test panels with dimensions of **24 by 24 inches (600 by 600 mm)** minimum and of average thickness of shotcrete, but not less than **4-1/2 inches (115 mm)**. Testing agency will obtain sets of test specimens from each test panel.

1. Compressive Strength Testing: One set of three unreinforced specimens. Test each set of unreinforced specimens for compressive strength according to construction testing requirements in ACI 506.2.
2. Visual Core Grading: One set of three reinforced specimens. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.

E. In-Place Shotcrete Testing: One set of three unreinforced cores for each mixture and for each workday or for every [**50 cu. yd. (38 cu. m)**] of shotcrete placed, whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C42/C42M. Do not cut steel reinforcement.

F. Strength of shotcrete will be considered satisfactory according to the following:

1. Specimen Cores: Mean compressive strength of each set of three unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
2. Specimen Cubes: Mean compressive strength of each set of three unreinforced cubes to equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.

G. Shotcrete will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

3.13 REPAIRS

A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.

1. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs.
2. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and **1/2 inch (13 mm)** deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders.
3. Dampen surfaces and apply new shotcrete.[**Match adjacent color and finish.**]

B. Repair core holes from in-place testing according to repair provisions in **ACI 301 (ACI 301M)**, except do not use shotcrete. Match adjacent color and finish.

3.14 CLEANING

A. Immediately remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 03 37 13 00

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Task	Specification	Specification Description
03 37 13 00	03 30 00 00	Cast-In-Place Concrete
03 37 16 00	03 30 00 00	Cast-In-Place Concrete
03 37 16 00	03 11 16 00	Architectural Concrete

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SECTION 03 38 16 00 - UNBONDED POST-TENSIONED CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Post-tensioning tendons and accessories, including pocket formers, bar chairs, slab bolsters, and nonprestressed reinforcement required for installing post-tensioning tendons, including the following:
2. Post-tensioning tendons and accessories, including pocket formers, bar chairs, slab bolsters, and nonprestressed reinforcement required for installing post-tensioning tendons, including the following:

    a. Support bars.
    b. Backup bars and hairpins at anchorages.
    c. Hairpins at locations of horizontal curvature.
    d. Supplemental reinforcement at blockouts.

3. Post-tensioning operations, including stressing, recording tendon elongations and gage pressures, and finishing tendons.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for concrete formwork and nonprestressed steel reinforcement, except for nonprestressed reinforcement.
2. Section 032000 "Concrete Reinforcing" for nonprestressed steel reinforcement, except for nonprestressed reinforcement required for installing post-tensioning tendons.
3. Section 033000 "Cast-in-Place Concrete" for concrete.

1.2 DEFINITIONS

A. Strand Tail: Excess strand length extending past the anchorage device.

B. Stressing Pocket: Void formed by pocket former at stressing-end anchorage that provides required cover over wedges and strand tail.

C. Wedge Cavity: Cone-shaped hole in anchorage device designed to hold the wedges that anchor the strand.

1.3 COORDINATION

A. Attachments and Penetrations:

1. Attach permanent construction, such as curtain-wall systems, handrails, fire-protection equipment, lights, and security devices to the post-tensioned slab using embedded anchors.
2. Drilled anchors, power-driven fasteners, and core drilling for sleeves or other penetrations are not allowed unless, as directed by the Owner.
3. Form penetrations within [**18 inches (460 mm)**] of an anchorage with ASTM A53/A53M,

Schedule 40 steel pipe.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review procedures related to installation and stressing of post-tensioning tendons, including, but not limited to, the following:

a. Construction schedule and availability of materials, personnel, and equipment needed to make progress and avoid delays.
b. Storage of post-tensioning materials on-site.
c. Structural load limitations.
d. Coordination of post-tensioning installation drawings and nonprestressed reinforcing steel placing drawings.
e. Horizontal and vertical tolerances on tendons and nonprestressed reinforcement placement.
f. Marking and measuring of elongations.
g. Submittal of stressing records and requirements for tendon finishing.
h. Removal of formwork.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Post-tensioning coating.
2. Tendon sheathing.
3. Anchorage devices.
4. Tendon couplers.
5. Bar and tendon supports.
6. Pocket formers.
7. Sheathing repair tape.
8. Stressing-pocket patching material.
9. Encapsulation system.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.

10. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing tendon layout, installation procedures, and the following:

1. Installation drawings, including plans, elevations, sections, and details.
2. Numbers, arrangement, and designation of post-tensioning tendons.
3. Tendon profiles and method of tendon support, including chair heights and locations. Show tendon profiles at sufficient scale to clearly indicate all support points with their associated heights.
4. Details for horizontal curvature around openings and at anchorages.
5. Locations of anchorages and blockouts required for stressing.
6. Anchorage details, including bundled tendon flaring.
7. Tendon clearances around slab openings and penetrations.
8. Construction joint locations and pour sequence.
9. Details for corners and other locations where tendon layouts may conflict with one another or with nonprestressed reinforcing steel.
10. Locations of nonprestressed reinforcement required for installing post-tensioning tendons, including, but not limited to, the following:

    a. Support bars.
    b. Backup bars and hairpins at anchorages.
    c. Hairpins at locations of horizontal curvature.
    d. Supplemental reinforcement at blockouts.

11. Stressing procedures and jacking force to result in final effective forces used in determining number of tendons required.
12. Calculated elongations for each tendon.

D. Samples: For the following products:

1. Anchorages with **24 inches (610 mm)** of coated, sheathed strand.
2. Couplers with **24 inches (610 mm)** of coated, sheathed strand.
3. Components of the encapsulation system, unassembled and clearly identified.

E. Delegated Design Submittal: For post-tensioning system.

1. Include sealed design calculations prepared by a qualified structural engineer indicating method of elongation calculation, including values used for friction coefficients, anchorage seating loss, elastic shortening, creep, relaxation, and shrinkage.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**testing agency**]. Include resume of individual supervising installation and stressing of post-tensioning tendons.

B. Evaluation Reports: For each type of anchorage device and coupler, from ICC-ES:

C. Product Certificates: For each type of encapsulation system.

D. Mill Test Reports: Certified mill test reports for prestressing strand used on Project, indicating that strand is low relaxation and including the following:

1. Coil numbers or identification.
2. Breaking load.

3. Load at 1 percent extension.
4. Elongation at failure.
5. Modulus of elasticity.
6. Diameter and net area of strand.

E. Field quality-control reports.

F. Procedures Statement: Procedures for cutting excess strand tail and patching stressing pocket.

G. Stressing Jack Calibration: Calibration certificates for jacks and gages to be used on Project. Calibrate each jack-and-gage set as a pair.

H. Stressing Records: Submit the same day as stressing operations.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Fabricating plant certified by PTI according to procedures set forth in PTI's "Manual for Certification of Plants Producing Unbonded Single Strand Tendons."

B. Installer Qualifications: A qualified installer whose full-time Project superintendent has successfully completed PTI's Level 1 - Field Fundamentals course or has equivalent verifiable experience and knowledge, as directed by the Owner.

1. Superintendent to be trained by post-tensioning supplier in the operation of stressing equipment to be used on Project.

C. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1. Testing Agency Inspector: Personnel performing field inspections and measuring elongations to have successfully completed PTI's Level 1 - Field Fundamentals course or to have equivalent verifiable experience and knowledge, as directed by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle post-tensioning materials according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain post-tensioning materials and equipment from single source.

1. Stressing jacks not provided by post-tensioning supplier must be calibrated and approved for use on Project by post-tensioning supplier.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality

Requirements," to design post-tensioned reinforcement.

B. Design structure to withstand the loads indicated according to governing codes, within limits and under conditions indicated.

C. Average Precompression:

1. Minimum Average Slab Precompression: [**125 psi (0.86 MPa)**][**200 psi (1.4 MPa)**].
2. Maximum Average Slab Precompression: [**300 psi (2.1 MPa)**][**500 psi (3.4 MPa)**].
3. Minimum Average Precompression in T-, L-, and Rectangular-Beam Cross Sections: [**200 psi (1.4 MPa)**].
4. Minimum Precompression in Slab Section Not Included in T- or L-Beam Section: [**100 psi (0.7 MPa)**].
5. Maximum Precompression in Transfer Girders: [**1000 psi (6.9 MPa)**]. Specify stage-stressing sequence to avoid overstress.

D. Comply with **ACI 318 (ACI 318M)** requirements unless more stringent requirements are indicated.

1. Limits on stresses at transfer of prestress and under service load.
2. Minimum bonded reinforcement.
3. Concrete cover over reinforcement.

E. Fire Resistance:

1. Design members such that thickness and concrete cover over reinforcement comply with the following:

a. Fire-resistance requirements of authorities having jurisdiction.
b. The following fire-resistance requirements:

1) Slabs: [**Two**] hours.
2) Beam: [**Two**] hours.

F. Deflection Limits, Including Creep and Shrinkage Effects, as Follows:

1. Total Dead Load: [**L/600**].
2. Total Dead Plus Live Load: [**L/360**].

G. Closure Strips: Locate closure strips at midspan and adjust tendon forces and profiles accordingly. Calculate moments in spans with closure strips assuming a continuous slab. Provide only nonprestressed reinforcement within closure strips. Design reinforcement in closure strip to carry ultimate moment at midspan.

2.3 PRESTRESSING TENDONS

A. ACI Publications: Comply with ACI 423.7 unless otherwise indicated.

B. Prestressing Strand: ASTM A416/A416M, **Grade 270 (Grade 1860)**, uncoated, seven-wire, low-relaxation, [**0.5-inch- (12.7-mm-)**][**0.6-inch- (15.2-mm-)**] diameter strand.

C. Post-Tensioning Coating: Compound with friction-reducing, moisture-displacing, and corrosion-inhibiting properties; chemically stable and nonreactive with prestressing strand, nonprestressed reinforcement, sheathing material, and concrete.

1. Minimum Coating Weight: [**2.5 lb (1.14 kg) for 0.5-inch- (12.7-mm-)**][**3 lb (1.36 kg) for 0.6-inch- (15.2-mm-)**] diameter strand per **100 feet (30 m)** of strand.
2. Completely fill annular space between strand and sheathing over entire tendon length with post-tensioning coating.

D. Tendon Sheathing:

1. Material: Polyethylene or polypropylene with a minimum density of **0.034 lb/cu. in. (0.9 g/cu. cm)**.
2. Minimum Thickness: [**0.050 inch (1.25 mm)**].
3. Continuous over length of tendon [**to provide watertight encapsulation of prestressing strand**][**and**][**between anchorages to prevent intrusion of cement paste or loss of coating for a nonencapsulated system**].

E. Anchorage and Coupler Assemblies: Assemblies of prestressing strand, wedges, and anchor or coupler complying with static and fatigue testing requirements and capable of developing 95 percent of actual breaking strength of strand.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**General Technologies, Inc.**]
   b. [**Hayes Specialty Machining, Ltd.**]
   c. [**Precision Sure-Lock, Inc.**]

2. Anchorage Bearing Stresses: Comply with ACI 423.7 for stresses at transfer load and service load.
3. Fixed-End Anchorage Assemblies: Plant fabricated with wedges seated at a load of not less than 80 percent and not more than 85 percent of breaking strength of strand.

F. Encapsulation System: Watertight encapsulation of prestressing strand consisting of the following:

1. Encapsulation Caps: Attached to anchorages with a positive mechanical connection and completely filled with post-tensioning coating.

   a. Encapsulation Caps for Fixed- and Stressing-End Anchorages: Designed to provide watertight encapsulation of wedge cavity. Sized to allow required extension of strand past the wedges.

      1) Attach encapsulation caps for fixed-end anchorages in fabricating plant.

   b. Encapsulation Caps at Intermediate Anchorages: Open to allow passage of strand.

2. Sleeves: Attached to anchorage with positive mechanical connection; overlapped a minimum of **4 inches (100 mm)** with sheathing and completely filled with post-tensioning coating.

2.4 NONPRESTRESSED STEEL BARS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**] percent.

B. Support Bars, Reinforcing Bars, and Hairpins:

1. Steel: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.
2. Low-Alloy Steel: ASTM A706/A706M, deformed.
3. Galvanized Steel: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, ASTM A767/A767M, [**Class I**][**Class II**] zinc coated after fabrication and bending.

    a. Zinc Repair Material: ASTM A780/A780M, zinc-based solder, paint containing zinc dust, or sprayed zinc.

4. Epoxy-Coated Steel: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, ASTM A775/A775M epoxy coated with less than 2 percent damaged coating in each **12-inch (300-mm)** bar length.

    a. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on bars and complying with ASTM A775/A755M. After fabricating bars, repair damaged areas according to ASTM D3963/D3963M.

C. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening tendons and tendon support bars in place. Manufacture bar supports, according to CRSI's "Manual of Standard Practice," from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. For uncoated bars, use [**all-plastic**][**CRSI Class 1 plastic-protected**][**CRSI Class 2 stainless steel**] bar supports.
2. For epoxy-coated bars, use [**CRSI Class 1A epoxy-coated or other dielectric-polymer-coated-wire**][**all-plastic**] bar supports.
3. For zinc-coated bars, use [**galvanized-wire or dielectric-polymer-coated-wire**][**all-plastic**] bar supports.

2.5 ACCESSORIES

A. Pocket Formers: Capable of completely sealing wedge cavity; sized to provide the required cover over the anchorage and allow access for cutting strand tail.

B. Anchorage Fasteners: [**Stainless**][**Galvanized**][**Uncoated**]-steel nails, wires, and screws used to attach anchorages to formwork.

C. Sheathing Repair Tape: Elastic, self-adhesive, moistureproof tape with minimum width of **2 inches (50 mm)**, in contrasting color to tendon sheathing; nonreactive with sheathing, coating, or prestressing steel.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**3M**]
    b. [**Adhesive Tape Products, Ltd**]
    c. [**Covalence Adhesives**]

2.6 PATCHING MATERIAL

A. Patching Material: One-component, polymer-modified, premixed patching material containing selected silica aggregates and portland cement, suitable for vertical and overhead applications. Do not use material containing chlorides or other chemicals known to be deleterious to prestressing steel or material that is reactive with prestressing steel, anchorage device material, or concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**Fox Industries, Inc.**]
c. [**Kaufman Products, Inc**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

PART 3 - EXECUTION

3.1 FORMWORK

A. Design formwork to support load redistribution that may occur during stressing operation. Ensure that formwork does not restrain elastic shortening, camber, or deflection resulting from application of prestressing force.

B. Do not remove forms supporting post-tensioned elements until tendons have been fully stressed and elongations, as directed by the Owner.

C. Do not place concrete in supported floors until tendons on supporting floors have been stressed and elongations, as directed by the Owner.

3.2 INSTALLATION OF NONPRESTRESSED STEEL REINFORCEMENT

A. Placement of nonprestressed steel reinforcement is specified in Section 032000 "Concrete Reinforcing." Coordinate placement of nonprestressed steel reinforcement with installation of post-tensioning tendons.

3.3 INSTALLATION OF TENDONS

A. Install tendons according to installation drawings and procedures stated in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."

1. Tolerances: Comply with tolerances in ACI 423.7 for beams and slabs.

B. Tendon Supports: Provide continuous slab bolsters or bars supported on individual high chairs spaced at a maximum of **42 inches (1070 mm)** o.c. to ensure tendons remain in their designated positions during construction operations and concrete placement.

1. Support tendons as required to provide profiles shown on installation drawings. Position supports at high and low points and at intervals not exceeding **48 inches (1220 mm)**. Ensure that tendon profiles between high and low points are smooth parabolic curves.
2. Attach tendons to supporting chairs and reinforcement without damaging tendon sheathing.
3. Support slab tendons independent of beam reinforcement.

C. Maintain tendon profile within maximum allowable deviations from design profile as follows:

1. **1/4 inch (6.3 mm)** for member depth less than or equal to **8 inches (200 mm)**.
2. **3/8 inch (9.5 mm)** for member depth greater than **8 inches (200 mm)** and less than or equal to **24 inches (610 mm)**.
3. **1/2 inch (13 mm)** for member depth greater than **24 inches (610 mm)**.

D. Maintain minimum radius of curvature of 480-strand diameters for lateral deviations to avoid openings, ducts, and embedded items. Maintain a minimum of **2 inches (50 mm)** of separation between tendons at locations of curvature.

E. Limit tendon bundles to [**five**] tendons. Do not twist or entwine tendons within a bundle. Maintain a minimum distance of **12 inches (300 mm)** between center of adjacent bundles.

F. If tendon locations conflict with nonprestressed reinforcement or embedded items, tendon placement governs. Obtain the Owner approval before relocating tendons or tendon anchorages that interfere with one another, as directed by the Owner.

G. Deviations in horizontal spacing and location of slab tendons are permitted when required to avoid openings and inserts.

H. Installation of Anchorages:

1. Place anchorages at locations shown on approved installation drawings.
2. Do not switch fixed- and stressing-end anchorage locations.
3. Attach pocket formers, intermediate anchorages, and stressing-end anchorages securely to bulkhead forms. Install stressing-end and intermediate anchorages perpendicular to tendon axis.
4. Install tendons straight, without vertical or horizontal curvature, for a minimum of **12 inches (300 mm)** behind stressing-end and intermediate anchorages.
5. Embed intermediate anchorage devices at construction joints in first concrete placed at joint.
6. Minimum splice length in reinforcing bars at anchorages is **24 inches (600 mm)**. Stagger splices a minimum of **60 inches (1500 mm)**.
7. Place fixed-end anchorages in formwork at locations shown on installation drawings. Support anchorages firmly to avoid movement during concrete placement.
8. Remove loose encapsulation caps on fixed-end anchorages, refill with post-tensioning coating, and re-attach encapsulation caps to achieve a watertight enclosure.

I. Maintain minimum concrete cover as follows:

1. From Exterior Edge of Concrete to Wedge Cavity: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**].
2. From Exterior Edge of Concrete to Strand Tail: [**3/4 inch (19 mm)**].
3. From Exterior Edge of Concrete to Wedge-Cavity Cap: [**1 inch (25 mm)**].
4. Top, Bottom, and Edge Cover for Anchorages: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**].

J. Maintain minimum clearance of **6 inches (150 mm)** between tendons and openings.

K. Prior to concrete placement, mark tendon locations on formwork with spray paint.

L. Do not install sleeves within [**36 inches (914 mm)**] of anchorages after tendon layout has been inspected.

M. Do not install conduit, pipe, or embeds requiring movement of tendons after tendon layout has been inspected.

N. Do not use couplers unless location has been approved by the Owner, as directed by the Owner.

3.4 SHEATHING INSPECTION AND REPAIR

A. Inspect sheathing for damage after installing tendons. Repair damaged areas by restoring post-tensioning coating and repairing or replacing tendon sheathing.

1. Ensure that sheathing is watertight and there are no air voids.
2. Follow tape repair procedures in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."

B. Maximum length of exposed strand behind anchorages is as follows:

1. Fixed End: [**12 inches (300 mm)**].
2. Intermediate and Stressing End: [**1 inch (25 mm)**].

a. Cover exposed strand with sheathing repair tape to prevent contact with concrete.

C. Immediately remove and replace tendons that have damaged strand.

3.5 CONCRETE PLACEMENT

A. Do not place concrete until placement of tendons and nonprestressed-steel reinforcement has been inspected by [**special inspector**][**testing agency**].

B. Provide as directed by the Owner and [**special inspector**][**testing agency**] a minimum of 48 hours' notice before concrete placement.

C. Ensure compaction of concrete around anchorages.

D. Ensure that position of tendons and nonprestressed-steel reinforcement do not change during concrete placement. Reposition tendons and nonprestressed-steel reinforcement moved during concrete placement to original location.

E. Ensure that method of concrete placement does not damage tendon sheathing. Do not support pump lines, chutes, or other concrete-placing equipment on tendons.

3.6 TENDON STRESSING

A. Calibrate stressing jacks and gages at start of project and at least every six months thereafter. Keep copies of calibration certificates for each jack-and-gage pair on Project site that are available for inspection. Exercise care in handling stressing equipment to ensure that proper calibration is maintained.

B. Stress tendons only under supervision of a qualified post-tensioning superintendent.

C. Do not begin stressing operations until concrete compressive strength has reached [**3000 psi (20.7 MPa)**] as indicated by tests of field-cured cylinders.

D. Complete stressing within [**96**] hours of concrete placement.

E. If concrete has not reached required compressive strength, obtain the Owner approval to partially stress tendons and delay final stressing until concrete has reached required strength, as directed by the Owner.

F. Stage stress [**transfer girders**][**foundation mats**] according to schedule shown on the Contract Drawings.

G. If detensioning and restressing of tendon is required, discard wedges used in original stressing and provide new wedges.

H. Mark and measure elongations according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons." Measure elongations to closest [**1/8 inch (3.2 mm)**].

I. Submit stressing records within one day of completion of stressing. If discrepancies between measured and calculated elongations exceed plus or minus 7 percent, resolve these discrepancies, as directed by the Owner.

J. Prestressing will be considered acceptable if gage pressures shown on stressing record correspond to required stressing force and calculated and measured elongations agree within 7 percent.

K. If measured elongations deviate from calculated elongations by more than 7 percent, perform additional testing, restressing, strengthening, or replacing of affected elements, as directed by the Owner.

L. Stressing Records: Testing agency records the following information during stressing operations:

1. Name of Project.
2. Date of approved installation drawings used for installation and stressing.
3. Floor number and concrete placement area.
4. Date of stressing operation.
5. Weather conditions, including temperature and rainfall.
6. Name and signature of inspector.
7. Name of individual in charge of stressing operation.
8. Serial or identification numbers of jack and gage.
9. Date of jack-and-gage calibration certificates.
10. Gage pressure to achieve required stressing force according to supplied calibration chart.
11. Tendon identification mark.
12. Calculated tendon elongation.
13. Actual tendon elongation.
14. Actual gage pressure.

3.7 TENDON FINISHING

A. Do not cut strand tails or cover anchorages until stressing records have been reviewed, as directed by the Owner.

B. Cut strand tails as soon as possible after approval of elongations.

C. Cut strand tail between **1/2 and 3/4 inch (13 and 19 mm)** from wedges. Do not damage tendon or concrete during removal of strand tail. Acceptable methods of cutting strand tail include the following:

1. Oxyacetylene flame.
2. Abrasive wheel.
3. Hydraulic shears.

4. Plasma cutting.

D. Install encapsulation caps and sleeves on intermediate anchorages within one day of stressing.

E. Cut strand tails and install encapsulation caps on stressing-end anchorages, as directed by the Owner.

F. Patch stressing pockets within one day of cutting strand tail. Clean inside surface of stressing pocket to remove laitance or post-tensioning coating before installing patching material. Finish patching material flush with adjacent concrete.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Before concrete placement, [**special inspector**][**testing agency**] will inspect the following for compliance with post-tensioning installation drawings and the Contract Documents:

   a. Location and number of tendons.
   b. Tendon profiles and cover.
   c. Installation of backup bars, hairpins, and other nonprestressed reinforcement shown on post-tensioning installation drawings.
   d. Installation of pocket formers and anchorage devices.
   e. Repair of damaged sheathing.
   f. Connections between sheathing and anchorage devices.

2. [**Special inspector**][**Testing agency**] will record tendon elongations during stressing.
3. [**Special inspector**][**Testing agency**] will immediately report deviations, as directed by the Owner.

B. Prepare test and inspection reports.

3.9 PROTECTION

A. Do not expose tendons to electric ground currents, welding sparks, or temperatures that would degrade components.

B. Protect exposed components within one workday of their exposure during installation.

C. Prevent water from entering tendons during installation and stressing.

D. Provide weather protection to stressing-end anchorages if strand tails are not cut within 10 days of stressing the tendons.

3.10 REPAIRS

A. Review repair procedures, as directed by the Owner.

B. Repairs requiring removal of concrete, review, as directed by the Owner.

END OF SECTION 03 38 16 00

Task	Specification	Specification Description
03 38 16 00	03 30 00 00	Cast-In-Place Concrete
03 39 00 00	03 30 00 00	Cast-In-Place Concrete
03 39 13 00	03 30 00 00	Cast-In-Place Concrete
03 39 13 00	03 11 16 00	Architectural Concrete
03 39 23 00	03 30 00 00	Cast-In-Place Concrete
03 39 23 23	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 41 00 00 - PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast structural concrete.
2. Thin brick and accessories.
3. Stone materials and accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for [**concrete topping and**]placing connection anchors in concrete.
2. Section 051200 "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.
3. Section 055000 "Metal Fabrications" for kickers and other miscellaneous steel shapes.
4. Section 071900 "Water Repellents" for water-repellent finish treatments.

1.2 DEFINITIONS

A. Design Reference Sample: Sample of approved precast structural concrete color, finish, and texture, as directed by the Owner.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight with no GreenScreen LT-1 or GHS Category 1 hazards.
b. Inventory or HPD to at least 0.01 percent by weight, with at least 75 percent assessed using GreenScreen Benchmark assessment.
c. Third-party-verified Declare product label, designated "Red List Free."

d. Material Health Certificate or Cradle to Cradle certification with minimum Bronze level of Material Health.

4. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

C. Design Mixtures: For each precast concrete mixture. Include compressive strength and, if required, water-absorption tests.

D. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
4. Indicate separate face and backup mixture locations and thicknesses.
5. Indicate type, size, and length of welded connections by AWS standard symbols.
6. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
7. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
8. Include and locate openings larger than **10 inches (250 mm)**. Where additional structural support is required, include header design.
9. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
10. Indicate relationship of precast structural concrete units to adjacent materials.
11. Indicate locations, dimensions, and details of thin-brick units, including corner units and special shapes, and joint treatment.
12. Indicate locations, dimensions, and details of stone facings, anchors, and joint widths.
13. Indicate estimated camber for precast floor slabs with concrete toppings.
14. Indicate shim sizes and grouting sequence.
15. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

E. Samples:

1. For each type of finish indicated on exposed surfaces of precast structural concrete units with architectural finish, in sets of three, representative of finish, color, and texture variations expected; approximately **12 by 12 by 2 inches (300 by 300 by 50 mm)**.

   a. Where other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.

2. Samples for each thin-brick unit required, showing full range of color and texture expected. Include Samples showing color and texture of joint treatment.

   a. Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing manufacturer's full range of colors.
   b. Grout Samples for Verification: Showing color and texture of joint treatment.

F. Delegated Design Submittals: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional

engineer responsible for their preparation.

1. Show precast structural concrete unit types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from precast structural concrete.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**fabricator**][**testing agency**].

B. Welding certificates.

C. Material Certificates: For the following:

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Insulation.
6. Structural-steel shapes and hollow structural sections.
7. Thin-brick units and accessories.
8. Stone anchors and accessories.

D. Material Test Reports: For aggregates, by a qualified testing agency.

E. Preconstruction test reports.

F. Source quality-control reports.

G. Field quality-control[**and special inspection**] reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as a PCI-certified plant as follows:

a. Group C, [**Category C1 - Precast Concrete Products (no prestressed reinforcement)**][**Category C2 - Prestressed Hollowcore and Repetitively Produced Products**][**Category C3 - Prestressed Straight Strand Structural Members**][**Category C4 - Prestressed Deflected Strand Structural Members**].
b. Group CA, [**Category C1A - Precast Concrete Products (no prestressed reinforcement)**][**Category C2A - Prestressed Hollowcore and Repetitively Produced Products**][**Category C3A - Prestressed Straight-Strand Structural Members**][**Category C4A - Prestressed Deflected-Strand Structural Members**].

B. Required Certified Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance, to erect [**Category S1 - Simple**][**Category S2 - Complex**] Structural Systems.

C. Installer Qualifications: An experienced precast concrete erector who has retained a "PCI-Certified Field

Auditor" to conduct a field audit of a project installed by erector in [**Category S1 - Simple**][**Category S2 - Complex**] Structural Systems and who can produce an Erectors' Post Audit Declaration, according to PCI MNL 127, "PCI Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products."

D. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

E. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

G. Sample Panels: After sample approval and before fabricating precast structural concrete units with [**architectural finish**][**thin-brick facing**][**stone facing**], produce a minimum of [**two**] sample panels approximately [**16 sq. ft. (1.5 sq. m)**] in area, as directed by the Owner. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.

1. Locate panels where indicated or, if not indicated, as directed by the Owner.
2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
3. After approval of repair technique, maintain one sample panel at fabricator's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove sample panels when directed.

H. Mockups: After sample panel approval but before production of precast structural concrete units with [**architectural finish**][**thin-brick facing**][**stone facing**], construct full-sized mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup as indicated on Drawings including [**sealants**] and precast structural concrete units with an architectural finish complete with anchors, connections, flashings, and joint fillers.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless as directed by the Owner.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Stone Anchor Testing: Engage a qualified testing agency to perform preconstruction testing according to ASTM C1354/C1354M or ASTM E488, modified as follows:

1. Furnish test specimens, including stone anchors, that are representative of materials proposed for incorporation into the Work.
2. Anchorage Tests: Test **12 inches (300 mm)** square samples for[**each combination of**] stone variety, orientation of cut, finish, and anchor type proposed for use on Project. Test for shear and tensile strength of anchorage system.

1.8 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
2. Place adequate dunnage of even thickness between each unit.
3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

D. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design precast structural concrete units[**including stone facing system**].

B. Design Standards: Comply with **ACI 318 (ACI 318M)** and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

C. Fire-Resistance Calculations: Where indicated, provide precast structural concrete units whose fire resistance meets prescriptive requirements of authorities having jurisdiction or has been calculated according to [**ACI 216.1 (ACI 216.1M)**][**PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete,"**] and is acceptable to authorities having jurisdiction.

D. Structural Performance:

1. Precast structural concrete units and connections to withstand design loads indicated within limits and under conditions indicated.
2. Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

a. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of **ACI 318 (ACI 318M)**.

1) Thermal Movements: Allow for in-plane thermal movements resulting from annual

ambient temperature changes of [**minus 18 to plus 120 deg F (minus 10 to plus 67 deg C)**][**120 deg F (67 deg C)**].

b. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

c. Vehicular Impact Loads: Design spandrel beams acting as vehicular barriers for passenger cars to resist a single [**6000-lbf (26.7-kN)**] load applied horizontally in any direction to the spandrel beam, with anchorages or attachments capable of transferring this load to the structure. Design spandrel beams assuming the load to act at a height of **18 or 27 inches (457 or 686 mm)** above the floor or ramp surface, whichever is more severe, on an area not to exceed **1 sq. ft. (0.0929 sq. m)**.

2.2 PRECAST STRUCTURAL CONCRETE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Coreslab Structures**]
2. [**GATE Precast Company**]
3. [**Wells Concrete**]

2.3 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

B. Form Liners: Units of face design, texture, arrangement, and configuration [**indicated**][**to match those used for precast concrete design reference sample**]. Furnish with manufacturer's recommended form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

C. Surface Retarder: Chemical set retarder, capable of temporarily delaying setting of newly placed concrete mixture to depth of reveal specified.

2.4 REINFORCING MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**] percent.

B. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

D. Galvanized Reinforcing Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**],

deformed bars, with ASTM A767/A767M, Class II zinc coating and chromate treatment.[**Galvanize after fabrication and bending.**]

E. Epoxy-Coated Reinforcing Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, [**ASTM A775/A775M**][**or**][**ASTM A934/A934M**] epoxy coated, with less than 2 percent damaged coating in each **12-inch (300-mm)** bar length.

F. Steel Bar Mats: ASTM A184/A184M, fabricated from [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, assembled with clips.

G. Plain-Steel Welded Wire Reinforcement: ASTM A185/A185M, fabricated from [**as-drawn steel**][**galvanized-steel**] wire into flat sheets.

H. Deformed-Steel Welded Wire Reinforcement: ASTM A497/A497M or ASTM A1064/A1064M, flat sheet.

I. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A coated, [**plain**][**deformed**], flat sheet, [**Type 1 bendable**][**Type 2 nonbendable**] coating.

J. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.5 PRESTRESSING TENDONS

A. Pretensioning Strand: [**ASTM A416/A416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, seven-wire**][**or**][**ASTM A886/A886M, Grade 270 (Grade 1860), indented, seven-wire**], low-relaxation strand.

B. Unbonded Post-Tensioning Strand: ASTM A416/A416M, **Grade 270 (Grade 1860)**, uncoated, seven-wire, low-relaxation strand.

1. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.7 and sheath with polypropylene tendon sheathing complying with ACI 423.7. Include anchorage devices and coupler assemblies.

C. Post-Tensioning Bars: ASTM A722/A722M, uncoated high-strength steel bar.

2.6 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Indigenous Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Portland Cement: ASTM C150/C150M, Type I or Type III, gray, unless otherwise indicated.

1. For surfaces exposed to view in finished structure, use gray or white cement, of same type, brand, and mill source.

D. Supplementary Cementitious Materials:

1. Pozzolans: ASTM C618, Class C, F, or N with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C618, Class N.
3. Silica Fume: ASTM C1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

E. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C33/C33M, with coarse aggregates complying with [**Class 5S**][**Class 5M**][**Class 4S**][**Class 4M**]. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.

a. Gradation: [**Uniformly graded**][**Gap graded**][**To match design reference sample**].

2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate to match approved finish sample.

F. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C330/C330M, with absorption less than 11 percent.

G. Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.

H. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

I. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.

J. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

1. Water-Reducing Admixtures: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing Admixture: ASTM C494/C494M, Type S.
8. Plasticizing and Retarding Admixture: ASTM C494/C494M, Type S.
9. Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

2.7 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A36/A36M.

B. Carbon-Steel-Headed Studs: ASTM A108, Grade 1010 through 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.

C. Carbon-Steel Plate: ASTM A283/A283M, Grade C.

D. Malleable-Iron Castings: ASTM A47/A47M, Grade 32510 or Grade 35028.

E. Carbon-Steel Castings: ASTM A27/A27M, **Grade 60-30 (Grade 415-205)**.

F. High-Strength, Low-Alloy Structural Steel: ASTM A572/A572M.

G. Carbon-Steel Structural Tubing: ASTM A500/A500M, Grade B or Grade C.

H. Wrought Carbon-Steel Bars: ASTM A675/A675M, **Grade 65 (Grade 450)**.

I. Deformed-Steel Wire or Bar Anchors: ASTM A496/A496M or ASTM A706/A706M.

J. Carbon-Steel Bolts and Studs: **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A563/A563M; and flat, unhardened steel washers, ASTM F844.

K. High-Strength Bolts, Nuts, and Washers:

1. ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

   a. Finish: [**Plain**][**Hot-dip zinc coating**][**Mechanically deposited zinc coating**].

2. ASTM F3125/F3125M, **Grade A490 (Grade A490M)**, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

L. Zinc-Coated Finish: For exterior steel items[**, steel in exterior walls,**] and items indicated for galvanizing, apply zinc coating by [**hot-dip process according to ASTM A123/A123M or ASTM A153/A153M**][**electrodeposition according to ASTM B633, SC 3, Types 1 and 2**].

1. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
2. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

M. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply [**lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79**][**SSPC-Paint 25**] according to SSPC-PA 1.

N. Welding Electrodes: Comply with AWS standards.

O. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

2.8 STAINLESS STEEL CONNECTION MATERIALS

A. Stainless Steel Plate: ASTM A240/A240M or ASTM A666, Type 304, Type 316, or Type 201.

B. Stainless Steel Bolts and Studs: **ASTM F593, Alloy Group 1 or 2 (ASTM F738M, Grade A1 or A4)**, hex-head bolts and studs; **ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or A4)** stainless

steel nuts; and flat, stainless steel washers.

1. Lubricate threaded parts of stainless steel bolts with an antiseize thread lubricant during assembly.

C. Stainless Steel-Headed Studs: ASTM A276/A276M, Alloy 304 or 316, with minimum mechanical properties of PCI MNL 116.

2.9 BEARING PADS

A. Provide one of the following bearing pads for precast structural concrete units[**as recommended by precast fabricator for application**]:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D2240; minimum tensile strength **2250 psi (15.5 MPa)**, ASTM D412.
2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D2240; capable of supporting a compressive stress of **3000 psi (20.7 MPa)** with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D2240; complying with AASHTO's "AASHTO LRFD Bridge Design Specifications," Division II, Section 18.10.2; or with MIL-C-882E.
4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.
5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

2.10 ACCESSORIES

A. Reglets Specified Elsewhere: Specified in Section 076200 "Sheet Metal Flashing and Trim."

B. Reglets: [**PVC extrusions,**][**Stainless steel, Type 302 or Type 304,**][**Copper,**] felt or fiber filled, or with face opening of slots covered.

C. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install structural precast concrete units.

2.11 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144 or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.

B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107/C1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.

C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C881/C881M, of type, grade, and class to suit requirements.

2.12 THIN BRICK AND ACCESSORIES

A. Thin Brick:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acme Brick Company**]
    b. [**Belden Brick Company (The)**]
    c. [**Endicott Clay Products Co**]
    d. [**General Shale, Inc.**]
    e. [**Glen-Gery Corporation**]

2. Thickness not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** thick, and as follows:

    a. Dimensional Tolerances: Plus **0 inch (0 mm)** or minus **1/16 inch (1.6 mm)** for any dimension **8 inches (203 mm)** or less and plus **0 inch (0 mm)** or minus **3/32 inch (2.4 mm)** for any dimension more than **8 inches (203 mm)**.
    b. Out-of-Square Tolerance: Plus or minus **1/16 inch (1.6 mm)**.
    c. Warpage Tolerance: Plus **0 inch (0 mm)** or minus **1/16 inch (1.6 mm)**.
    d. Variation of Shape from Specified Angle: Plus or minus one degree.
    e. Modulus of Rupture: Not less than **250 psi (1.7 MPa)** when tested according to ASTM C67/C67M.
    f. Tensile Bond Strength: Not less than **150 psi (1.0 MPa)** when tested before and after freeze-thaw test according to ASTM E488 as modified. Adhere a steel plate with a welded rod on a single thin-brick face with epoxy for each test.
    g. 24-Hour Cold-Water Absorption: Not more than 6 percent when tested according to ASTM C67/C67M.
    h. Freeze-Thaw Resistance: No detectable disintegration or separation after 300 freezing-and-thawing cycles when tested according to ASTM C666/C666M, Method B.
    i. Chemical Resistance: Tested according to ASTM C650 and rated "not affected."
    j. Efflorescence: Tested according to ASTM C67/C67M and rated "not effloresced."
    k. Surface Coating: Thin brick with colors or textures applied as coatings to withstand 50 cycles of freezing and thawing; ASTM C67/C67M with no observable difference in applied finish when viewed from **10 ft. (3 m)**.
    l. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.

B. Regional Materials: Brick shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

C. Indigenous Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

D. Special Shapes: Include corners, edge corners, and end edge corners.

E. Face Size: [**2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long**][**2-1/4 inches (57 mm) high**

by 11-5/8 inches (295 mm) long][3-5/8 inches (92 mm) high by 7-5/8 inches (194 mm) long][3-5/8 inches (92 mm) high by 11-5/8 inches (295 mm) long].

F. [**Where indicated to "match existing,"**] provide thin brick matching color, texture, and face size of existing adjacent brick work, as directed by the Owner.

G. Face Color and Texture: **as directed by the Owner**

H. Sand-Cement Mortar: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.

I. Pointing Grout: Packaged, polymer-modified, sanded grout complying with ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**C-Cure**]
c. [**Custom Building Products**]
d. [**DAP Products Inc.**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]

2. Polymer Type: Acrylic resin in [**dry, redispersible form, packaged with other dry ingredients**][**liquid-latex form for adding packaged dry-grout mix**].
3. Colors: [**As indicated by manufacturer's designations**][**as directed by the Owner**].

2.13 STONE MATERIALS AND ACCESSORIES

A. Stone facing for precast structural concrete is specified in Section 044200 "Exterior Stone Cladding."

B. Anchors: Stainless steel, ASTM A276/A276M, Type 304 or Type 316, of temper and diameter required to support loads without exceeding allowable design stresses.

1. Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.

C. Silicone, Nonstaining, S, NS, 25, NT, M: Chemically curing, elastomeric, single-component, nonsag, neutral-curing, silicone sealant; Class 25, Use NT (nontraffic), and Use M (masonry) that complies with applicable requirements in Section 079200 "Joint Sealants" and that does not stain stone:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
b. [**The Dow Chemical Company**]
c. [**Tremco Incorporated**]

D. Urethane, S, NS, 25, T, M: Chemically curing, elastomeric, single-component, nonsag, urethane sealant; Class 25, Use T (traffic), and Use M (masonry) that complies with applicable requirements in Section 079200 "Joint Sealants" and that does not stain stone:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**Master Builders Solutions**]
b. [**Sika Corporation**]
c. [**Tremco Incorporated**]

E. Epoxy Filler: ASTM C881/C881M, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.

1. Elastomeric Anchor Sleeve: **1/2 inch (13 mm)** long; 60 Shore, Type A durometer hardness; ASTM D2240.

F. Bond Breaker: [**Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick][Polyethylene sheet, ASTM D4397, 6 to 10 mils (0.15 to 0.25 mm) thick**].

2.14 INSULATED FLAT-WALL PANEL ACCESSORIES

A. Molded-Polystyrene Board Insulation: ASTM C578, [**Type XI, 0.70 lb/cu. ft. (12 kg/cu. m)][Type I, 0.90 lb/cu. ft. (15 kg/cu. m)][Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)][Type II, 1.35 lb/cu. ft. (22 kg/cu. m)][Type IX, 1.80 lb/cu. ft. (29 kg/cu. m)**]; [**square**][**ship-lap**] edges; thickness as directed by the Owner.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type X, 1.30 lb/cu. ft. (21 kg/cu. m)][Type IV, 1.55 lb/cu. ft. (26 kg/cu. m)][Type VI, 1.80 lb/cu. ft. (29 kg/cu. m)][Type VII, 2.20 lb/cu. ft. (35 kg/cu. m)][Type V, 3.00 lb/cu. ft. (48 kg/cu. m)**]; [**square**][**ship-lap**] edges; thickness as directed by the Owner

C. Polyisocyanurate Board Insulation: ASTM C591, [**Type I, 1.8 lb/cu. ft. (29 kg/cu. m)][Type II, 2.5 lb/cu. ft. (40 kg/cu. m)][Type III, 3.0 lb/cu. ft. (48 kg/cu. m)**] unfaced, thickness as directed by the Owner

D. Wythe Connectors: [**Glass-fiber-reinforced vinylester connectors][Polypropylene pin connectors][Stainless steel pin connectors][Bent galvanized reinforcing bars][Galvanized welded wire trusses][Galvanized bent wire connectors][Epoxy-coated carbon-fiber grid][Fiberglass trusses**] manufactured to connect wythes of precast concrete panels.

2.15 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
2. Limit use of fly ash to [**20**][**35**] percent replacement of portland cement by weight and ground granulated blast-furnace slag to [**20**][**50**] percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by **ACI 318 (ACI 318M)** or PCI MNL 116 when tested according to ASTM C1218/C1218M.

D. Normal-Weight Concrete Mixtures: Proportion [**face mixtures**][**face and backup mixtures**][**full-depth mixture**][**face and backup mixtures or full-depth mixtures, at fabricator's option**] by either laboratory trial batch or field test data methods according to ACI PRC-211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): **5000 psi (34.5 MPa)**.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: For structural precast concrete with an architectural finish, limit water absorption to 6 percent by weight or 14 percent by volume, tested according to ASTM C642, except for boiling requirement.

F. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI PRC-211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:

1. Compressive Strength (28 Days): **5000 psi (34.5 MPa)**.
2. Unit Weight: Calculated equilibrium unit weight of **115 lb/cu. ft. (1842 kg/cu. m)**, plus or minus **3 lb/cu. ft. (48 kg/cu. m)**, according to ASTM C567/C567M.

G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.

H. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

I. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.16 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

1. Place form liners accurately to provide finished surface texture indicated. Provide solid backing

and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.

B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Form joints are not permitted on faces of structural precast concrete with an architectural finish that is exposed to view in the finished work.
2. Edge and Corner Treatment: Uniformly [**chamfered**][**radiused**].

2.17 THIN-BRICK FACINGS

A. Place form-liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.

B. Securely place thin-brick units face down into form-liner pockets and place concrete backing mixture.

C. Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.

D. Mix and install pointing grout according to ANSI A108.10. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading pointing grout onto faces of thin-brick units. Remove excess pointing grout immediately to prevent staining of thin brick.

1. Tool joints to a [**slightly concave**][**V-**]shape when pointing grout is thumbprint hard.

E. Clean faces and joints of thin-brick facing.

2.18 STONE FACINGS

A. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Keep concrete reinforcement a minimum of **3/4 inch (19 mm)** from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

1. Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not more than **24 inches (600 mm)** o.c. around perimeter of stone facing panels with a minimum of four anchors per panel.

B. Fill anchor holes with [**sealant filler and install anchors**][**epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone**].

1. Install minimum **0.006-inch- (0.15-mm-)** thick polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.
2. Install **1/8-inch (3-mm)** polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

2.19 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than **10 inches (250 mm)** in any dimension. Do not drill or cut openings or prestressing strand without the Owner approval, as directed by the Owner.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified in ASTM A775/A775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel and prestressing strand to maintain at least **3/4-inch (19-mm)** minimum concrete cover. Increase cover requirements for reinforcing steel to **1-1/2 inches (38 mm)** when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.

1. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete unit.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.
5. Protect strand ends and anchorages with a minimum of **1-inch- (25-mm-)** thick, nonmetallic,

nonshrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.

H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

I. Place face mixture to a minimum thickness after consolidation of the greater of **1 inch (25 mm)** or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.

J. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

1. Place backup concrete mixture to ensure bond with face-mixture concrete.

K. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.

L. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

M. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

N. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

O. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116, as directed by the Owner.

2.20 CASTING INSULATED WALL PANELS

A. Cast, screed, and consolidate wythe supported by mold.

B. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.

C. Ensure bottom wythe and insulation layer are not disturbed after bottom wythe reaches initial set.

D. Cast, screed, and consolidate top wythe to meet required finish.

E. Maintain temperature below **150 deg F (65 deg C)** in bottom concrete wythe.

2.21 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

B. Thin-Brick-Faced Precast Structural Concrete Units: Restrict the following misalignments to 2 percent of number of thin bricks in a unit:

1. Alignment of Mortar Joints:

   a. Jog in Alignment: **1/8 inch (3 mm)**.
   b. Alignment with Panel Centerline: Plus or minus **1/8 inch (3 mm)**.

2. Variation in Width of Exposed Mortar Joints: Plus or minus **1/8 inch (3 mm)**.
3. Tipping of Individual Thin Bricks from the Panel Plane of Exposed Thin-Brick Surface: Plus **0 inch (0 mm)**; minus **1/4 inch (6 mm)** less than or equal to depth of form-liner joint.
4. Exposed Thin-Brick Surface Parallel to Primary Control Surface of Panel: Plus **1/4 inch (6 mm)**; minus **1/8 inch (3 mm)**.
5. Individual Thin-Brick Step in Face from Panel Plane of Exposed Thin-Brick Surface: Plus **0 inch (0 mm)**; minus **1/4 inch (6 mm)** less than or equal to depth of form-liner joint.

C. Stone Veneer-Faced Precast Structural Concrete Units:

1. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus **1/4 inch (6 mm)**.
2. Variation in Joint Width: **1/8 inch in 36 inches (3 mm in 900 mm)** or a quarter of nominal joint width, whichever is less.
3. Variation in Plane between Adjacent Stone Units (Lipping): **1/16-inch (1.6-mm)** difference between planes of adjacent units.

2.22 COMMERCIAL FINISHES

A. Commercial Grade: Remove fins and protrusions larger than **1/8 inch (3 mm)** and fill holes larger than **1/2 inch (13 mm)**. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to **3/16 inch (5 mm)**.

B. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than **1/2 inch (13 mm)** caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than **1/4 inch (6 mm)** in width that occur more than once per **2 sq. in. (1300 sq. mm)**. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to **1/8 inch (3 mm)**.

C. Grade B Finish: Fill air pockets and holes larger than **1/4 inch (6 mm)** in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than **1/8 inch (3 mm)** in width that occur more than once per **2 sq. in. (1300 sq. mm)**. Grind smooth form offsets or fins larger than **1/8 inch (3 mm)**. Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.

D. Grade A Finish: Repair surface blemishes and fill air holes with the exception of air holes **1/16 inch (1.6 mm)** in width or smaller, and form marks where the surface deviation is less than **1/16 inch (1.6 mm)**. Float apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration at form joints is permitted. Grind smooth all form joints.

E. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a

uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.

F. Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

G. Apply roughened surface finish according to **ACI 318 (ACI 318M)** to precast concrete units that receive concrete topping after installation.

2.23 COMMERCIAL ARCHITECTURAL FINISHES

A. Manufacture member faces free of joint marks, grain, and other obvious defects with corners, including false joints, uniform and straight. Finish exposed-face surfaces of precast concrete units to match approved [**design reference sample**][**sample panels**][**mockups**] and as follows:

1. Design Reference Sample: as directed by the Owner.
2. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
3. As-Cast-Surface Finish: Provide surfaces to match approved sample or mockup for acceptable surface, air voids, sand streaks, and honeycomb.
4. Textured-Surface Finish: Impart by form liners or inserts.
5. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
6. Exposed-Aggregate Finish: Use chemical-retarding agents applied to concrete molds and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
7. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
8. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.
9. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
10. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
11. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
12. Thin-Brick Facing: See "Thin-Brick Facings" Article.
13. Stone Facing: See "Stone Facings" Article.

2.24 SOURCE QUALITY CONTROL

A. Testing Agency: [**as directed by the Owner**] a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

B. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements and ASTM C1610/C1610M, ASTM C1611/C1611M, ASTM C1621/C1621M, and ASTM C1712.

1. Test and inspect self-consolidating concrete according to PCI TR-6.

C. Strength of precast structural concrete units is considered deficient if units fail to comply with **ACI 318**

(ACI 318M) requirements for concrete strength.

D. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42/C42M.

1. A minimum of three representative cores to be taken from units of suspect strength, from locations, as directed by the Owner.
2. Test cores in an air-dry condition or, if units are wet under service conditions, test cores after immersion in water in a wet condition.
3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Report test results in writing on same day that tests are performed, with copies to the Owner, Contractor, and precast concrete fabricator, as directed by the Owner. Test reports include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to the Owner approval. The Owner reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
4. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

1. Do not permit connections to disrupt continuity of roof flashing.

D. Field cutting of precast units is not permitted as directed by the Owner.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

F. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum **4.0-mil- (0.1-mm-)** thick coat of galvanized repair paint to galvanized surfaces according to ASTM A780/A780M.
3. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
4. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
2. For slip-critical connections, use one of the following methods to assure proper bolt pretension:

a. Turn-of-Nut: According to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."
b. Calibrated Wrench: According to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."
c. Twist-off Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.
d. Direct-Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.

3. For slip-critical connections, use method and inspection procedure approved by as directed by

the Owner and coordinated with inspection agency.

H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

1. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces.
2. Fill joints completely without seepage to other surfaces.
3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
4. Place grout end cap or dam in voids at ends of hollow-core slabs.
5. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
6. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator, as directed by the Owner.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**as directed by the Owner**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Erection of precast structural concrete members.

B. Testing Agency: [**as directed by the Owner**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Visually inspect field welds and test according to ASTM E165 or to ASTM E709 and ASTM E1444. High-strength bolted connections are subject to inspections.

D. Testing agency will report test results promptly and in writing to the Owner, as directed by the Owner.

E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, to be performed to determine compliance of replaced or additional work with specified requirements.

G. Prepare test and inspection reports.

3.5 REPAIRS

A. Repair precast structural concrete units, as directed by the Owner.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of **20 ft. (6 m)**.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780/A780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as directed by the Owner.

3.6 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 03 41 00 00

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Task	Specification	Specification Description
03 41 16 00	03 41 00 00	Precast Structural Concrete
03 41 19 00	03 41 00 00	Precast Structural Concrete
03 41 23 00	03 41 00 00	Precast Structural Concrete
03 41 26 00	03 38 16 00	Unbonded Post-Tensioned Concrete
03 41 26 00	03 41 00 00	Precast Structural Concrete
03 41 33 00	03 41 00 00	Precast Structural Concrete
03 48 29 00	03 41 00 00	Precast Structural Concrete
03 48 46 00	03 41 00 00	Precast Structural Concrete
03 48 49 00	03 41 00 00	Precast Structural Concrete

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SECTION 03 51 13 00 - CEMENTITIOUS WOOD FIBER DECKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Monolithic cementitious wood-fiber plank units.
2. Composite cementitious wood-fiber plank units.
3. Cementitious wood-fiber tile units.
4. Subpurlins and grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include details at supports, reinforcement at openings, and attachment to other work.

C. Samples: Show texture, finish, and edge and end configurations of each type of cementitious wood-fiber unit, [**12 inches (305 mm)**][**24 inches (610 mm)**] long by width of unit.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: For cementitious wood-fiber units, for tests performed by a qualified testing agency.

C. Evaluation Reports: For cementitious wood-fiber deck, from ICC-ES.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect cementitious wood-fiber units from moisture.

B. Store units on elevated platforms at Project site in a dry, well-ventilated, covered space and stack according to manufacturer's written instructions.

C. Handle units to prevent chipping, breaking, cracking, staining, soiling, warping, or other physical damage. Discard damaged units at time of installation.

1.6 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit work to be performed according to manufacturers' written instructions and warranty requirements.

B. Protect cementitious wood-fiber deck from moisture during installation and while exposed to the weather until permanently covered with subsequent construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**] or less.
2. Smoke-Developed Index: [**50**][**450**] or less.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Noise Reduction Coefficient (NRC): [**NRC 0.55**][**NRC 0.60**][**NRC 0.65**][**NRC 0.70**][**NRC 0.75**][**NRC 0.80**]; ASTM C423.

D. Light Reflectance: 60 percent; ASTM E1349.

2.2 MONOLITHIC CEMENTITIOUS WOOD-FIBER PLANK UNITS

A. Monolithic Plank: Manufacturer's standard, tongue-and-groove-edged, cementitious wood-fiber units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]

2. Thickness: [**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Size: Manufacturer's standard width; length [**to span a minimum of two supports**][**as indicated**].
4. End Configuration: Square.
5. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

B. Channel-Reinforced Monolithic Plank: Manufacturer's standard, tongue-and-groove-edged, cementitious wood-fiber planks with factory-installed, cold-formed, **0.060-inch- (1.5-mm-)** thick, galvanized-steel channel set in grooved edge; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]

2. Thickness: [**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Size: Manufacturer's standard width; length [**to span a minimum of two support spacings**][**as indicated**].
4. End Configuration: Square.

C. Concealed-Tee Monolithic Plank: Manufacturer's standard cementitious wood-fiber units, **3 inches (76 mm)** thick, with edges kerfed, back rabbeted, and beveled.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]

2. Size: Manufacturer's standard width; length [**to span a minimum of two support spacings**][**as indicated**].
3. End Configuration: Square.
4. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

2.3 COMPOSITE CEMENTITIOUS WOOD-FIBER PLANK UNITS

A. Insulated Composite Plank Type IV XPS: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base, ASTM C578, Type IV extruded-polystyrene insulation, and top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with DOC PS 2, **7/16 inch (11 mm)** thick; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]

2. Cementitious Wood-Fiber Base Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Insulation Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**5 inches (127 mm)**][**6 inches (152 mm)**][**7 inches (177 mm)**][**8 inches (202 mm)**].
4. Size: Manufacturer's standard width and of length indicated.
5. End Configuration: Square.
6. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

B. Insulated Composite Plank Type I XPS: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base, ASTM C578, Type I expanded-polystyrene insulation, and top layer of APA-rated oriented-strand-board

sheathing, Exposure 1 complying with DOC PS 2, **7/16 inch (11 mm)** thick; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]

2. Cementitious Wood-Fiber Base Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Insulation Thickness: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**5-1/4 inches (133 mm)**][**6-1/2 inches (165 mm)**][**7 inches (177 mm)**][**8 inches (202 mm)**].
4. Size: Manufacturer's standard width and of length indicated.
5. End Configuration: Square.
6. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

C. Composite Nailable Surface Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base, insulation, and top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with DOC PS 2, **7/16 inch (11 mm)** thick.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]

2. Thickness: [**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**].
3. Size: Manufacturer's standard width and of length indicated.
4. End Configuration: Square.
5. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

2.4 CEMENTITIOUS WOOD-FIBER TILE UNITS

A. Monolithic Tile: Manufacturer's standard, rabbet-edged, cementitious wood-fiber units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]

2. Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**5 inches (127 mm)**].
3. Size: [**24-inch (610-mm)**][**32-inch (813-mm)**][**48-inch (1219-mm)**] nominal width and of length indicated.

4. End Configuration: [**Square**][**Tongue and groove**].
5. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

B. Insulated Composite Tile: Manufacturer's standard factory-laminated composite deck units consisting of a rabbet-edged, cementitious wood-fiber tile base, ASTM C578, Type IV extruded-polystyrene insulation, and top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with DOC PS 2, **7/16 inch (11 mm)** thick; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Cementitious Wood-Fiber Tile Base Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Insulation Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**5 inches (127 mm)**][**6 inches (152 mm)**][**7 inches (177 mm)**][**8 inches (202 mm)**].
4. Size: [**24-inch (610-mm)**][**32-inch (813-mm)**][**48-inch (1219-mm)**] nominal width and of length indicated.
5. End Configuration: [**Square**][**Tongue and groove**].
6. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

2.5 SUBPURLINS AND GROUT

A. Bulb-Tee Subpurlins: Hot-rolled steel bulb tees, complying with ASTM A499, of length required to span three support spacings; shop painted with metal primer.

B. Gypsum Concrete Grout: Factory-packaged, gypsum concrete grout formulation recommended by cementitious wood-fiber unit manufacturer with a minimum compressive strength of **500 psi (3.45 MPa)**.

2.6 ACCESSORIES

A. Anchor Clips: Manufacturer's standard formed anchor clips of **0.0478-inch- (1.21-mm-)** thick minimum, galvanized-steel sheet, of type and configuration required for deck system indicated.

B. Screws: Manufacturer's recommended corrosion-resistant screw fasteners and washers, self-drilling, self-tapping, of length required for deck and structural framing indicated.

C. Nails: Manufacturer's recommended corrosion-resistant nails of size and length required for deck and structural framing indicated.

D. Adhesive: Manufacturer's recommended construction adhesive complying with APA AFG-01.

E. Filler Strips: Insulation strips, same as used in manufacture of insulated composite cementitious wood-fiber units.

F. Polyethylene Film: **0.004 inch (0.10 mm)** thick, complying with ASTM D4397.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine structural support framing for compliance with requirements, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing cementitious wood-fiber deck.

1. Install fastenings [**according to manufacturer's written instructions unless otherwise indicated**][**as indicated**].

B. Deck Interruptions: Provide barrier seals or blocking at overhangs to form wind seals and at partitions and walls to form sound seals unless otherwise indicated.

3.3 ROOF DECK INSTALLATION

A. Plank Roof Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports unless otherwise indicated. Tightly nest tongue-and-groove edges and tightly butt end joints.

1. Cut panels to provide starter units.
2. Continuously support plank edges and ends at perimeter of building and at openings in deck.
3. Mechanically fasten planks to supports and perimeter members.
4. Adhesively and mechanically fasten planks to supports and perimeter members. Apply adhesive to tongue-and-groove edges.

B. Concealed-Tee Plank Roof Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports unless otherwise indicated. Install flange of bulb tee into kerfed edge and tightly butt adjoining plank to engage other flange. Tightly [**nest tongue-and-groove**][**butt square**] end joints.

1. Cut panels to provide starter units.
2. Continuously support plank edges and ends at perimeter of building and at openings in deck.
3. Mechanically fasten planks to supports and perimeter members.
4. Adhesively and mechanically fasten planks to supports and perimeter members. Apply adhesive to tongue-and-groove edges.
5. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of plank and feather uneven top surfaces to a plane.

C. Monolithic Tile and Subpurlin Roof Deck: Space subpurlin members as indicated. Attach subpurlins to each support with **3/4-inch- (19-mm-)** long minimum, fillet welds on both sides of flanges at ends of members and on alternate sides at intermediate structural supports.

1. Lay tile with rabbeted edges supported on subpurlins.
2. Lay tile with square-cut ends concealed [**and supported on cross subpurlins**][**over supporting purlins or beams**].

3. Lay tile with tongue-and-groove ends exposed in pattern indicated.
4. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of tile and feather uneven top surfaces to a plane.

D. Composite Tile and Subpurlin Roof Deck: Space subpurlin members as indicated. Attach subpurlins to each support with **3/4-inch- (19-mm-)** long minimum, fillet welds on both sides of flanges at ends of members and on alternate sides at intermediate structural supports.

1. Lay tile with rabbeted edges supported on subpurlins.
2. Lay tile with square-cut ends concealed [**and supported on cross subpurlins**][**over supporting purlins or beams**].
3. Lay tile with tongue-and-groove ends exposed in pattern indicated.
4. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top surface of cementitious wood-fiber base. Fill remainder of joint with filler strips of insulation.

3.4 FORM-DECK INSTALLATION

A. Plank Form Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports unless otherwise indicated. Tightly nest tongue-and-groove edges and tightly butt end joints.

1. Cut panels to provide starter units.
2. Continuously support plank edges and ends at perimeter of building and at openings in deck.
3. Cover exposed edges and ends of form planks with polyethylene film before pouring cast-in-place fill to prevent paste or mixing water from penetrating deck and seeping through to bottom face. Remove exposed film after cast-in-place fill has set.

B. Shoring: Provide shoring of sufficient strength to withstand weight of cast-in-place fill and construction traffic.

1. Comply with **ACI 318 (ACI 318M)** and ACI 301 for design, installation, and removal of shoring and reshoring.

    a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

2. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 CLEANING AND PROTECTION

A. Protect top surfaces of deck from damage caused by construction operations.

B. Protect exposed bottom surfaces of deck from soiling and damage during handling and construction.

C. Clean exposed bottom surfaces of completed deck and touch up minor damage to surfaces, as directed by the Owner.

D. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that cementitious wood-fiber deck is without damage or deterioration at time of Substantial Completion.

E. Remove and replace deteriorated and damaged deck units.

END OF SECTION 03 51 13 00

SECTION 03 53 00 00 - CONCRETE TOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emery-aggregate concrete floor topping.
2. Iron-aggregate concrete floor topping.
3. Concrete floor topping for standard applications.
4. Decorative concrete floor topping.
5. Polishable concrete floor topping.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each concrete floor topping, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

B. Field quality-control reports[**by as directed by the Owner**].

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.6 MOCKUPS

A. Build mockups [**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**to set quality standards for fabrication and installation**][**and**][**for preconstruction testing**].

1. Build mockups approximately **100 sq. ft. (9.3 sq. m)** in the location indicated or, if not indicated, as directed by the Owner.

B. Concrete floor topping mockups are to demonstrate typical joints where applicable, surface finish, bonding, texture, tolerances, and standard of workmanship.

1. Subject to compliance with requirements, approved mockups may become part of the completed

Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete floor topping performance.

1. Place concrete floor topping only when ambient temperature and temperature of base slabs are between **50 and 86 deg F (10 and 30 deg C)**.

B. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 CONCRETE FLOOR TOPPINGS

A. Emery-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded, crushed emery aggregate containing not less than 50 percent aluminum oxide, not less than 24 percent ferric oxide, and not more than 8 percent silica; portland cement or blended hydraulic cement; plasticizers; and other admixtures to which only water needs to be added at Project site.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**Laticrete International, Inc.**]
c. [**Metalcrete Industries**]
d. [**Vulcan Materials Company**]

2. Performance Criteria:

a. Set Time: ASTM C403/C403M.
b. Impact Resistance: ACI 544.2.
c. Flexural Strength: ASTM C78/C78M.
d. Abrasion Resistance: ASTM C944/C944M.

3. Compressive Strength Minimum (28 Days): [**10,000 psi (69 MPa)**]; ASTM C109/C109M.

B. Iron-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded iron aggregate, portland cement, plasticizers, and other admixtures to which only water needs to be added at Project site.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   c. [**Master Builders Solutions**]
   d. [**Metalcrete Industries**]
   e. [**Vulcan Materials Company**]

2. Performance Criteria:

   a. Set Time: ASTM C403/C403M.
   b. Impact Resistance: ACI 544.2.
   c. Flexural Strength: ASTM C78/C78M.
   d. Abrasion Resistance: ASTM C944/C944M.

3. Compressive Strength (28 Days): Minimum [**12,000 psi (83 MPa)**]; ASTM C109/C109M.

C. Concrete Floor Topping for Standard Applications: Non-industrial, cement-based self-leveling interior concrete topping or resurfacing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Laticrete International, Inc.**]
   c. [**Schonox HPS North America, Inc.**]
   d. [**Sika Corporation**]

2. Performance Criteria:

   a. Application: Barrel mix or pump.
   b. Flow Time: Minimum 10 minutes.
   c. Initial Set: Not less than 10 minutes.
   d. Final Set: Not less than 45 minutes.
   e. Compressive Strength (28 Days): Minimum [**4,000 psi (27.58 MPa)**][**6,000 psi (41.37 MPa)**][**7,000 psi (48 MPa)**]; ASTM C109/C109M.

3. Materials:

   a. Normal-Weight Aggregate: ASTM C33/C33M. Provide from single source. Well-graded, washed gravel.
   b. Coloring: as directed by the Owner.
   c. Primer: As recommended by manufacturer.
   d. Sealer: As recommended by manufacturer.

4. Thickness: [**As indicated on Drawings**][**1/8 inch to 2 inches (3.175 mm to 50.8 mm)**][**1/4 inch to 2 inches (6.35 mm to 50.8 mm)**][**Up to 5 inches (127 mm) with aggregates**].

D. Decorative Concrete Floor Topping: Non-industrial cement-based self-leveling interior concrete topping as a decorative overlay or micro-topping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Laticrete International, Inc.**]
   c. [**Schonox HPS North America, Inc.**]
   d. [**Sika Corporation**]

2. Performance Criteria:

   a. Abrasion Resistance: ASTM C779/C779M.
   b. Impact Strength: ASTM C805/C805M.

3. Co-efficient of Friction: ASTM C1679, materials meet levels of finish as recommended in writing by manufacturer.
4. Materials:

   a. Polymer-modified, cementitious, single-component topping.
   b. Coloring: as directed by the Owner.
   c. Primer: As recommended by manufacturer.
   d. Sealer: As recommended by manufacturer.

5. Thickness: [**As indicated on Drawings**][**1/16 inch to 2 inches (1.58 mm to 50.8 mm)**].

E. Polishable Concrete Floor Topping: Non-industrial, cement-based self-leveling interior concrete topping suitable to receive a mechanical polish process.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Laticrete International, Inc.**]
   c. [**Schonox HPS North America, Inc.**]
   d. [**Sika Corporation**]

2. Description: Polymer-modified cementitious single component topping.

   a. Coloring: Materials as recommended in writing by manufacturer, as directed by the Owner.
   b. Primer: As recommended in writing by manufacturer.
   c. Sealer: As recommended in writing by manufacturer.

3. Performance Criteria:

a. Compressive Strength (28 Days): Minimum [**6,000 psi (41.37 MPa)**][**7,000 psi (48 MPa)**]; ASTM C109/C109M.
b. Flexural Strength: Minimum **1,000 psi (70 kg/cm2)** at 28 days, ASTM C348.
c. Abrasion Resistance: ASTM D4060.
d. Tensile Strength: ASTM C1583/C1583M.

4. Thickness: [**As indicated on Drawings**][**3/8 inch to 2 inches (9.52 mm to 50.8 mm)**].

2.2 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq m)** when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, 25 percent solids content, minimum.

2.3 RELATED MATERIALS

A. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids [**epoxy resin with a Type A Shore durometer hardness of 80**][**aromatic polyurea with a Type A Shore durometer hardness range of 90 to 95**] in accordance with ASTM D2240.

B. Joint-Filler Strips: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**or**][**ASTM D1752, cork or self-expanding cork**].

C. Portland Cement: ASTM C150/C150M, Type I or II.

D. Sand: ASTM C404, fine aggregate passing **No. 16 (1.18 mm)** sieve.

E. Water: Potable.

F. Acrylic-Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

G. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined by ASTM C219.

H. Bond-Breaker Membrane: ASTM D2178/D2178M, asphalt-glass felt, Type III, standard ply sheet.

I. Crack and Joint Repair:

1. Crack repair materials as recommended in writing by concrete topping manufacturer.
2. Joint sealant materials as recommended in writing by concrete topping manufacturer.

J. Epoxy Adhesive: ASTM C881/C881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

K. Power-Actuated Fasteners: Fastener systems with an evaluation report based on ICC-ES AC70.

L. Nonslip Aggregate Materials: As recommended in writing by concrete topping manufacturer.

M. Concrete Hardener and Dustproofer: Chemical clear liquid hardener which produces a dense, hard and dustproof concrete surface.

N. Moisture Control System: As required for Project, and as recommended in writing by manufacturer.

O. Low-Viscosity Rigid Polyurethane Crack and Joint Repair: As recommended in writing by manufacturer.

P. Semi-Rigid Joint Sealant: As recommended in writing by manufacturer.

Q. Topical Color: as directed by the Owner.

R. Resilient Emulsion: As recommended in writing by manufacturer.

S. Integral Color: as directed by the Owner. Pigment type as recommended in writing by manufacturer.

2.4 MIXING

A. Bonding Slurry:

1. Mix portland cement with water to a thick paint consistency.
2. Mix 1 part portland cement and [**1-1/2**][**2**][**2-1/2**] parts sand with water[**and an acrylic-bonding agent in accordance with manufacturer's written instructions**] to a thick paint consistency.

B. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer in accordance with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of the Work.

B. Verify that base concrete slabs comply with scratch finish requirements specified in Section 033000 "Cast-in-Place Concrete."

C. Verify that base slabs are visibly dry and free of moisture. Test for capillary moisture by the plastic sheet method in accordance with ASTM D4263.

D. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of **1/4 inch (6 mm)**.

1. Prepare and clean existing base slabs in accordance with concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
2. Mechanically remove contaminants from existing concrete that might impair bond of floor topping.
3. Saw cut contraction and construction joints in existing concrete to a depth of **1/2 inch (13 mm)** and fill with semirigid joint filler.
4. To both sides of joint edges and at perimeter of existing base slab, [**mechanically remove a 4-inch- (100-mm-) wide and 0- to 1-inch- (0- to 25-mm-) deep, tapered wedge of concrete and retexture surface**][**install concrete nails in manufacturer's recommended staggered pattern**].

B. Install joint-filler strips where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated on Drawings.

1. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface unless otherwise indicated on Drawings.
2. Terminate full-width, joint-filler strips **1/2 inch (13 mm)** below topping surface where joint sealants are indicated, in accordance with Section 079200 "Joint Sealants."
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

C. Install power-actuated fasteners in accordance with written directions of floor topping manufacturer at perimeter of areas that are to receive floor topping, including both edges of locations where joints will be formed in floor topping.

D. Primers: Provide priming at locations indicated on Drawings, and as recommended in writing by manufacturer.

3.3 APPLICATION OF FLOOR TOPPING

A. Begin floor topping application in presence of manufacturer's technical representative.

B. Monolithic Floor Topping: After textured float finish is applied to fresh concrete of base slabs installed in accordance with Section 033000 "Cast-in-Place Concrete," place concrete floor topping while concrete is still plastic.

C. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of **1/16 to 1/8 inch (1.6 to 3 mm)**, without puddling. Place floor topping while slurry is still tacky.

D. Existing Concrete: Apply epoxy-bonding adhesive, mixed in accordance with manufacturer's written instructions, and scrub into dry base slabs to a thickness of **1/16 to 1/8 inch (1.6 to 3 mm)**, without puddling. Place floor topping while adhesive is still tacky.

E. Aggregate Concrete Topping: Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

1. Screed surface with a straightedge and strike off to correct elevations.
2. Slope surfaces uniformly where indicated.
3. Begin initial floating, using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

F. Overlay or Micro-Topping: Apply in strict compliance with manufacturer's written installation instructions. Mix and spread material on to the surface with recommended squeegees and trowels.

G. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.

1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.

a. Finish surfaces to specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15, and [**measure**][**notify independent testing agency to permit measurement**] within 24 hours in accordance with ASTM E1155 for a randomly trafficked floor surface.
b. Finish and measure surface, so gap at any point between surface and an unleveled freestanding **10-ft.- (3-m-)** long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed **1/4 inch (6 mm)**.

H. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as directed by the Owner.

1. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.

I. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3-mm-)** wide joints into concrete floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

1. Form joints in concrete floor topping over contraction joints in base slabs unless otherwise indicated.
2. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
3. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than **1/2 inch (13 mm)** deep.

3.4 PROTECTING AND CURING

A. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.

B. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply in accordance with manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.

C. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, in accordance with concrete floor topping manufacturer's written instructions:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with [**water**][**continuous water-fog spray**][**or**][**absorptive cover, water saturated and kept continuously wet. Cover topping surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers**].
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof

tape.

3. Curing Compound: Apply uniformly in two coats in continuous operations by power spray or roller in accordance with manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.5 JOINT FILLING

A. Prepare and clean contraction joints and install semirigid joint filler, in accordance with manufacturer's written instructions, once topping has fully cured.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

3.6 REPAIR

A. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**as directed by the Owner will engage**][**Engage**] a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing and inspecting of completed applications of concrete floor toppings to take place in successive stages, in areas of extent and using methods as follows:

1. Sample Sets: At point of placement, a set of three molded-cube samples to be taken from the topping mix for the first **1000 sq. ft.** **(93 sq. m)**, plus one set of samples for each subsequent **5000 sq. ft.** **(464 sq. m)** of topping, or fraction thereof, but not less than six samples for each day's placement. Samples to be tested in accordance with ASTM C109/C109M for compliance with compressive-strength requirements.
2. Concrete floor topping to be tested for delamination by dragging a steel chain over the surface.
3. Concrete floor topping to be tested for compliance with surface flatness and levelness tolerances.

C. Remove and replace applications of concrete floor topping where test results indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 03 53 00 00

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Task	Specification	Specification Description
03 53 14 00	03 53 00 00	Concrete Topping
03 53 19 00	03 53 00 00	Concrete Topping

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SECTION 03 54 00 00 - GYPSUM CEMENT UNDERLAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-leveling, gypsum cement underlayment for application below interior floor coverings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum cement underlayment.
2. Reinforcement.
3. Primer.
4. Corrosion-resistant coating.
5. Surface sealer.
6. Sound control mat.

B. Sustainable Design Submittals:

1. Product Data: For coatings, indicating VOC content.
2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans indicating substrates, locations, and average depths of underlayment based on survey of substrate conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Test Reports:

1. For fire-resistant ratings, from a qualified testing agency.
2. For STC-rated assemblies, from a qualified testing agency.
3. For IIC-rated assemblies, from a qualified testing agency.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment products required for this Project.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.

1. Place gypsum cement underlayments only when ambient temperature and temperature of substrates are between **50 and 80 deg F (10 and 27 deg C)**.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

1. STC Rating: [**60**][**55**][**50**][**As indicated on Drawings**].

C. IIC-Rated Assemblies: For IIC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E492 and classified according to ASTM E989 by an independent testing agency.

1. IIC Rating: [**60**][**55**][**50**][**As indicated on Drawings**].

2.2 GYPSUM CEMENT UNDERLAYMENTS

A. Gypsum Cement Underlayment: Self-leveling, gypsum cement product that can be applied in minimum uniform thickness of [**1/8 inch (3 mm)**] to match adjacent floor elevations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arcosa Inc.**]
b. [**ARDEX Americas**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Hacker Industries, Inc.**]
e. [**MAPEI Corporation**]
f. [**Maxxon Corporation**]
g. [**Schonox HPS North America, Inc.**]
h. [**USG Corporation**]

2. Cement Binder: Gypsum or blended gypsum cement as defined by ASTM C219.
3. Compressive Strength: Not less than [2500 psi (17.2 MPa)][4000 psi (27.6 MPa)][5000 psi (34.5 MPa)] at 28 days when tested according to ASTM C472.
4. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer, formulated for use with underlayment when applied to substrate and conditions indicated.

B. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3 to 6 mm); or coarse sand as recommended by underlayment manufacturer.

1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.

C. Water: Potable and at a temperature of not more than 70 deg F (21 deg C).

D. Reinforcement: For underlayment applied to wood substrates, provide galvanized metal lath or other corrosion-resistant reinforcement recommended in writing by underlayment manufacturer.

E. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.

1. VOC Content: Provide coating with VOC content of 250 g/L or less.
2. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Material Emissions and Pollutant Control: Coating shall comply with either of the following:

    a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
    b. VOC Content: Provide coating with VOC content of 250 g/L or less.

6. Emissions Requirements: Coating shall comply with either of the following:

    a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    b. VOC Content: Provide coating with VOC content of 100 g/L or less.

F. Corrosion-Resistant Coating: Recommended in writing by underlayment manufacturer for metal substrates.

1. VOC Content: Provide coating with VOC content of 250 g/L or less.
2. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

5. Material Emissions and Pollutant Control: Coating shall comply with either of the following:

    a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
    b. VOC Content: Provide coating with VOC content of 250 g/L or less.

6. Emissions Requirements: Coating shall comply with either of the following:

    a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    b. VOC Content: Provide coating with VOC content of 100 g/L or less.

G. Surface Sealer: Designed to reduce porosity as recommended by manufacturer for type of floor covering to be applied to underlayment.

2.3 ACCESSORIES

A. Sound Control Mat: As required to meet STC and IIC ratings, manufactured by gypsum cement underlayment manufacturer.

1. Thickness: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**3/4 inch (19 mm)**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of the Work.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare and clean substrate according to manufacturer's written instructions.

1. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
2. Fill substrate voids to prevent underlayment from leaking.

B. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test, ASTM F1869: Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m)**] in 24 hours.
b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**85**] percent relative humidity level measurement, or as recommended by gypsum cement underlayment manufacturer.

C. Wood Substrates: Mechanically fasten loose boards and panels to eliminate substrate movement and squeaks. Sand to remove coatings that might impair underlayment bond and remove sanding dust.

1. Install underlayment reinforcement recommended in writing by manufacturer.

D. Metal Substrates: Mechanically remove, according to manufacturer's written instructions, rust, foreign matter, and other contaminants that might impair underlayment bond. Apply corrosion-resistant coating compatible with underlayment if recommended in writing by underlayment manufacturer.

E. Nonporous Substrates: For ceramic tile, quarry tile, and terrazzo substrates, remove waxes, sealants, and other contaminants that might impair underlayment bond; prepare surfaces according to manufacturer's written instructions.

F. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.

G. Sound Control [**Mat**][**and**][**Board**]: Install sound control materials according to manufacturer's written instructions.

1. Do not install mechanical fasteners that penetrate through the sound control materials.

3.3 INSTALLATION

A. Mix and install underlayment components according to manufacturer's written instructions.

1. Close areas to traffic during underlayment installation and for time period after installation recommended in writing by manufacturer.
2. Coordinate installation of components to provide optimum adhesion to substrate and between coats.
3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.

B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Install underlayment to produce uniform, level surface.

1. Install a final layer without aggregate to product surface.
2. Feather edges to match adjacent floor elevations.

D. Cure underlayment according to manufacturer's written instructions. Prevent contamination during installation and curing processes.

E. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.

F. Apply surface sealer at rate recommended by manufacturer.

G. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

3.4 INSTALLATION TOLERANCES

A. Finish and measure surface, so gap at any point between gypsum cement underlayment surface and an unleveled, freestanding, **10-foot- (3.05-m-)** long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/4 inch (6 mm)**][**3/16 inch (4.8 mm)**][**1/8 inch (3 mm)**][**1/8 inch (3 mm) and 1/16 inch (1.6 mm) in 2 feet (610 mm)**].

3.5 PROTECTION

A. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION 03 54 00 00

SECTION 03 54 16 00 - HYDRAULIC CEMENT UNDERLAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polymer-modified, self-leveling, hydraulic cement underlayment for application below interior floor coverings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Hydraulic cement underlayment.
2. Reinforcement.
3. Primer.
4. Corrosion-resistant coating.
5. Surface sealer.
6. Sound control mat.

B. Sustainable Design Submittals:

1. Product Data: For coatings, indicating VOC content.
2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans indicating substrates, locations, and average depths of underlayment based on survey of substrate conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Test Reports:

1. For fire-resistant ratings, from a qualified testing agency.
2. For STC-rated assemblies, from a qualified testing agency.
3. For IIC-rated assemblies, from a qualified testing agency.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment

products required for this Project.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.

1. Place hydraulic cement underlayments only when ambient temperature and temperature of substrates are between **50 and 80 deg F (10 and 27 deg C)**.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

1. STC Rating: [**60**][**55**][**50**][**As indicated on Drawings**].

C. IIC-Rated Assemblies: For IIC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E492 and classified according to ASTM E989 by an independent testing agency.

1. IIC Rating: [**60**][**55**][**50**][**As indicated on Drawings**].

2.2 HYDRAULIC CEMENT UNDERLAYMENTS

A. Hydraulic Cement Underlayment: Polymer-modified, self-leveling, hydraulic cement product that can be applied in minimum uniform thickness of **1/4 inch (6 mm)** and that can be feathered at edges to match adjacent floor elevations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arcosa Inc.**]
b. [**ARDEX Americas**]
c. [**Atlas Construction Supply, Inc**]
d. [**CMP Specialty Products; a Bostik Brand**]
e. [**Combimix Inc.**]
f. [**Custom Building Products**]

g. [**Dayton Superior Corporation**]
h. [**Dependable, LLC**]
i. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
j. [**H.B. Fuller Construction Products Inc. / TEC**]
k. [**Hacker Industries, Inc.**]
l. [**J.E. Tomes**]
m. [**KOSTER American Corporation**]
n. [**Lambert Corporation**]
o. [**Laticrete International, Inc.**]
p. [**MAPEI Corporation**]
q. [**Master Builders Solutions**]
r. [**Maxxon Corporation**]
s. [**Metalcrete Industries**]
t. [**Schonox HPS North America, Inc.**]
u. [**Silpro Corporation**]
v. [**US SPEC, Division of US MIX Company**]
w. [**USG Corporation**]
x. [**Uzin Utz North America, Inc.**]

2. Cement Binder: ASTM C150/C150M, portland cement, or hydraulic or blended hydraulic cement as defined by ASTM C219.
3. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at 28 days when tested according to ASTM C109/C109M.
4. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer, formulated for use with underlayment when applied to substrate and conditions indicated.

B. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)**; or coarse sand as recommended by underlayment manufacturer.

1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.

C. Water: Potable and at a temperature of not more than **70 deg F (21 deg C)**.

D. Reinforcement: For underlayment applied to wood substrates, provide galvanized metal lath or other corrosion-resistant reinforcement recommended in writing by underlayment manufacturer.

E. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.

1. VOC Content: Provide coating with VOC content of 250 g/L or less.
2. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Material Emissions and Pollutant Control: Coating shall comply with either of the following:

a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

b. VOC Content: Provide coating with VOC content of 250 g/L or less.

6. Emissions Requirements: Coating shall comply with either of the following:

a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. VOC Content: Provide coating with VOC content of 100 g/L or less.

F. Corrosion-Resistant Coating: Recommended in writing by underlayment manufacturer for metal substrates.

1. VOC Content: Provide coating with VOC content of 250 g/L or less.
2. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Material Emissions and Pollutant Control: Coating shall comply with either of the following:

a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
b. VOC Content: Provide coating with VOC content of 250 g/L or less.

6. Emissions Requirements: Coating shall comply with either of the following:

a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. VOC Content: Provide coating with VOC content of 100 g/L or less.

G. Surface Sealer: Designed to reduce porosity as recommended by manufacturer for type of floor covering to be applied to underlayment.

2.3 ACCESSORIES

A. Sound Control Mat: As required to meet STC and IIC ratings, manufactured by hydraulic cement underlayment manufacturer.

1. Thickness: [1/8 inch (3 mm)][1/4 inch (6 mm)][3/8 inch (10 mm)][3/4 inch (19 mm)].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of the Work.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare and clean substrate according to manufacturer's written instructions.

1. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
2. Fill substrate voids to prevent underlayment from leaking.

B. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test, ASTM F1869: Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m)**] in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**85**] percent relative humidity level measurement, or as recommended by hydraulic cement underlayment manufacturer.

C. Wood Substrates: Mechanically fasten loose boards and panels to eliminate substrate movement and squeaks. Sand to remove coatings that might impair underlayment bond and remove sanding dust.

1. Install underlayment reinforcement recommended in writing by manufacturer.

D. Metal Substrates: Mechanically remove, according to manufacturer's written instructions, rust, foreign matter, and other contaminants that might impair underlayment bond. Apply corrosion-resistant coating compatible with underlayment if recommended in writing by underlayment manufacturer.

E. Nonporous Substrates: For ceramic tile, quarry tile, and terrazzo substrates, remove waxes, sealants, and other contaminants that might impair underlayment bond, and prepare surfaces according to manufacturer's written instructions.

F. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.

G. Sound Control [**Mat**][**and**][**Board**]: Install sound control materials according to manufacturer's written instructions.

1. Do not install mechanical fasteners that penetrate through the sound control materials.

3.3 INSTALLATION

A. Mix and install underlayment components according to manufacturer's written instructions.

1. Close areas to traffic during underlayment installation and for time period after installation recommended in writing by manufacturer.
2. Coordinate installation of components to provide optimum adhesion to substrate and between coats.
3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.

B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Install underlayment to produce uniform, level surface.

1. Install a final layer without aggregate to product surface.
2. Feather edges to match adjacent floor elevations.

D. Cure underlayment according to manufacturer's written instructions. Prevent contamination during installation and curing processes.

E. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.

F. Apply surface sealer at rate recommended by manufacturer.

G. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

3.4 INSTALLATION TOLERANCES

A. Finish and measure surface, so gap at any point between hydraulic cement underlayment surface and an unleveled, freestanding, **10-foot- (3.05-m-)** long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/4 inch (6 mm)**][**3/16 inch (4.8 mm)**][**1/8 inch (3 mm)**][**1/8 inch (3 mm) and 1/16 inch (1.6 mm) in 2 feet (610 mm)**].

3.5 PROTECTION

A. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION 03 54 16 00

Task	Specification	Specification Description
03 54 16 00	03 54 00 00	Gypsum Cement Underlayment
03 61 16 00	01 11 19 00	No Specification Required
03 62 13 00	03 41 00 00	Precast Structural Concrete
03 62 16 00	03 41 00 00	Precast Structural Concrete
03 63 00 00	03 37 13 00	Shotcrete
03 64 23 00	03 41 00 00	Precast Structural Concrete
03 64 26 00	01 11 19 00	No Specification Required
03 81 00 00	02 41 19 13	Cutting and Patching
03 81 13 00	02 41 19 13	Cutting and Patching
03 81 16 00	02 41 19 13	Cutting and Patching

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SECTION 04 01 00 00 - MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Paint removers.
2. Cleaning materials.
3. Liquid strippable masking agent.

1.2 ALLOWANCES

A. Allowances for cleaning masonry are specified in Section 012100 "Allowances."

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 DEFINITIONS

A. Very Low-Pressure Spray: Under [**100 psi (690 kPa)**].

B. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**].

C. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**].

D. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**].

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to cleaning masonry, including, but not limited to, the following:

a. Scheduling a pre-mockup meeting.
b. Manufacturer's representative of cleaning materials to be present during testing for consultation.
c. Mockup locations.
d. Masonry types.
e. Soiling types.
f. Verify masonry-cleaning equipment and facilities needed to make progress and avoid delays.
g. Materials, material application, and sequencing.
h. Cleaning types and cleaning methods.
i. Quality-control program.

j. Review cleaning program.
k. Coordination with building occupants.

1.6 SEQUENCING AND SCHEDULING

A. Work Sequence: Perform masonry-cleaning Work in the following sequence:

1. Remove plant growth and any other biological growth.
2. Inspect for open mortar joints. Where repairs are required, delay further cleaning Work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint or graffiti.
4. Clean masonry surfaces.
5. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning.

B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units and joints in accordance with masonry repair Sections.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions and application instructions.
2. Include test data substantiating that products comply with requirements.

B. Material certificates signed by manufacturer and Contractor certifying that each material complies with requirements.

C. Each type of chemical cleaning material.

D. Qualification data for firms and specialists to demonstrate their capabilities and experience. Include list of five completed projects with project names and references.

E. Cleaning Program:

1. Describe cleaning protocol, materials, methods, and equipment to be used.
2. Indicate protection of surrounding materials on people, vehicles, buildings, and site items.
3. Describe control method of runoff during operations.
4. Create written report of final cleaning methods and process used.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**paint-remover manufacturer**][**and**][**chemical-cleaner manufacturer**].

B. Preconstruction Test Reports: For cleaning materials and methods.

C. Cleaning program.

1.9 QUALITY ASSURANCE

A. Source of Materials: Obtain materials for masonry cleaning from a single source for each type of substrate required to ensure quality of cleaning.

B. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, who employs factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

C. Masonry-Cleaning Specialist Firms: A firm that provides masonry cleaning, including masonry cleaners that have been used for similar applications with successful results, and is manufacturer authorized for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

D. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, who employs factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

E. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

F. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.

1. If materials and methods other than those indicated are proposed for any phase of cleaning Work, add a written description of such materials and methods, including evidence of successful use on comparable projects and demonstrations to show their effectiveness for this Project.

1.10 MOCKUPS

A. Prepare mockups of cleaning on existing surfaces to evaluate and establish cleaning materials and processes. Consult cleaning manufacturer for project applications.

1. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].
2. Cleaning: Clean an existing area [**approximately 25 sq. ft. (2.3 sq. m)**][**as indicated**] for each type of masonry and surface condition.

    a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
    b. Consult with chemical cleaning product manufacturer to verify what products require pre-wetting of substrate before cleaner application.
    c. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.
    d. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.11 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage one or more chemical-cleaner[**and paint-remover**] manufacturers to perform preconstruction testing on masonry surfaces.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to Project in undamaged condition.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.13 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning Work to be performed in accordance with product manufacturers' written instructions and specified requirements.

B. Clean masonry surfaces only when air temperature is **40 deg F (4 deg C)** and above and is predicted to remain so for at least seven days after completion of cleaning.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and above and will remain so until masonry has thawed and dried out, but not less than seven days after completion of cleaning.
2. Hot-Weather Requirements: Protect unit masonry Work when temperature and humidity conditions produce excessive evaporation of water from masonry. Provide artificial shade and wind breaks and use cooled materials as required.

C. Refer to chemical cleaner manufacturer's recommendations for application techniques when hot-weather conditions exist.

PART 2 - PRODUCTS

2.1 PAINT REMOVERS

A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation, for removing paint from masonry; containing no methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
d. [**EaCo Chem, Inc.**]

e. [**Hydroclean; Hydrochemical Techniques, Inc**]
f. [**PROSOCO, Inc**]
g. [**Shore Corporation**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming, alkaline paste or gel formulation, for removing paint from masonry; containing no methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
c. [**Dumond Chemicals, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

C. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation, for removing paint from masonry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**Hydroclean; Hydrochemical Techniques, Inc**]
c. [**PROSOCO, Inc**]
d. [**Shore Corporation**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

D. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation, for removing paint from masonry; containing no methanol or methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Dumond Chemicals, Inc**]

d. [**EaCo Chem, Inc.**]
e. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

E. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation, for removing paint coatings from masonry; containing no methanol or methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dumond Chemicals, Inc**]
b. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

2.2 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **5 quarts (5 L)** of 5 percent sodium hypochlorite (bleach), and **15 quarts (15 L)** of hot water for every **5 gal. (20 L)** of solution required.

E. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning masonry surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cathedral Stone Products, Inc.**]
b. [**Price Research, Ltd. dba Charles Paint Research**]
c. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra**

cotta][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

F. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Cathedral Stone Products, Inc.**]
   c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
   d. [**Dumond Chemicals, Inc**]
   e. [**Hydroclean; Hydrochemical Techniques, Inc**]
   f. [**Price Research, Ltd. dba Charles Paint Research**]
   g. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

G. Mild-Acid Cleaner: Manufacturer's standard mild-acid cleaner containing no muriatic (hydrochloric), hydrofluoric, or sulfuric acid; or ammonium bifluoride or chlorine bleaches.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Cathedral Stone Products, Inc.**]
   c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
   d. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

H. Acidic Cleaner: Manufacturer's standard acidic masonry cleaner composed of hydrofluoric acid or ammonium bifluoride blended with other acids, detergents, wetting agents, and inhibitors.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Cathedral Stone Products, Inc.**]
   c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
   d. [**Dumond Chemicals, Inc**]
   e. [**EaCo Chem, Inc.**]
   f. [**Hydroclean; Hydrochemical Techniques, Inc**]

g. [**Price Research, Ltd. dba Charles Paint Research**]
h. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

I. One-Part Limestone Acidic Cleaner: Manufacturer's standard one-part acidic formulation for cleaning limestone.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**EaCo Chem, Inc.**]
d. [**Hydroclean; Hydrochemical Techniques, Inc**]
e. [**Price Research, Ltd. dba Charles Paint Research**]
f. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

J. Two-Part Chemical Cleaner: Manufacturer's standard system consisting of potassium- or sodium-hydroxide-based, alkaline prewash cleaner and acidic afterwash cleaner that does not contain hydrofluoric acid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
c. [**Hydroclean; Hydrochemical Techniques, Inc**]
d. [**Price Research, Ltd. dba Charles Paint Research**]
e. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

K. Poultices Cleaners: Manufacturer's temporary cleaning coating designed to remove dirt and stains without water in its application or removal. Consult manufacturer for strength level to fit project masonry substrates.

1. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

2.3 LIQUID STRIPPABLE MASKING AGENT

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Price Research, Ltd. dba Charles Paint Research**]
c. [**PROSOCO, Inc**]

2.4 ACCESSORY MATERIALS

A. Retain materials of use based on the approval of a mockup.

1. Provide materials with previous effectiveness in performing the Work involved.

a. Include materials with minimal possibility of damaging exposed surfaces.
b. Materials with consistency of each application.
c. Materials that provide uniformity of the resulting overall appearance.

B. Do not use products or tools that could do the following:

1. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces.
2. Leave residue on surfaces.

C. Equipment: Provide equipment for controlled spray application of water and chemical cleaners.

1. For chemical cleaner spray applications, provide a low-pressure tank or chemical pump suitable for the chemical cleaner indicated, equipped with spray tip for cleaning method applications.

D. Natural bristles brushes only.

E. Wood scrappers.

F. Trowels.

G. Provide additional accessories applicable to project conditions, including tapes, sheets, etc., to suit Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate conditions with specialist present, for compliance with approved mockup requirements for cleaning type, methods, products, and other conditions affecting performance.

3.2 PREPARATION

A. General: Comply with each manufacturer's written instructions for protecting people, motor vehicles, surrounding buildings, masonry areas not to be cleaned, nonmasonry surfaces, landscaping, equipment, and other surfaces that could be injured or harmed by such Work.

1. Provide temporary protective covers over pedestrian walkway areas and at points of entrance and exit for people, motor vehicles, and equipment that must remain during duration of cleaning procedures.
2. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant.
3. Temporarily protect all open joints to prevent intrusion of washing waters into the wall structure or building interior.
4. Remove all extraneous items no longer in use on face of surface unless indicated to remain, as directed by the Owner.
5. Apply masking agents in accordance with manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
6. Neutralize alkaline and acid wastes before disposal where applicable.

B. Provide disposal of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Remove[**gutters and**] downspouts and associated hardware adjacent to immediate work area and store during masonry cleaning. Reinstall when masonry cleaning is complete.

1. Provide temporary rain drainage during work to direct water away from building.

3.3 APPLICATION OF PRELIMINARY CLEANING MATERIALS

A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods.

1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.
2. Removing Biological Growth: Completely remove visible biological, moss, and shrub growth from masonry surfaces. Carefully remove biological growths, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and biological debris from open joints to whatever depth they occur.
3. Mold, Mildew, and Algae Removal:

    a. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
    b. Apply mold, mildew, and algae remover by brush[**or low-pressure spray**].
    c. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
    d. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove mold, mildew, and algae remover and soil.

B. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.4 APPLICATION OF PAINT REMOVER

A. Paint-Remover Application, General: Apply paint removers in accordance with paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

B. Paint Removal with Alkaline Paste Paint Remover:

1. Remove loose and peeling paint using [**low**][**medium**][**high**]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
5. Repeat process if necessary to remove all paint.
6. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
7. Rinse with cold water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
8. Remove asphalt and tar with [**solvent-type paste paint remover**].

    a. Apply paint remover only to asphalt and tar by brush without prewetting.
    b. Allow paint remover to remain on surface for 10 to 30 minutes.
    c. Repeat application if needed.

C. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

1. Remove loose and peeling paint using [**low**][**medium**][**high**]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover in accordance with manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
7. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
8. Rinse with cold water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.

D. Paint Removal with Solvent-Type Paste Paint Remover: .

1. Remove loose and peeling paint using [**low**][**medium**][**high**]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats in accordance with manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.

4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.

E. Paint Removal with Covered, Solvent-Type Paste Paint Remover: .

1. Remove loose and peeling paint using [**low**][**medium**][**high**]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover in accordance with manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.

F. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.5 GENERAL APPLICATION OF CLEANING METHODS

A. Chemical Cleaning: Do not apply during winds of enough force to spread them to unprotected surfaces.

B. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from [**20 ft. (6 m)**][**50 ft. (15 m)**], as directed by the Owner.

C. Proceed with cleaning in an orderly manner; work from [**bottom to top**][**top to bottom**] of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.

D. Use only those cleaning methods indicated for each masonry material and location.

1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.

    a. Equip units with pressure gages.
    b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
    c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
    d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
    e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.
    f. For steam application, use steam generator capable of delivering live steam at nozzle.

E. Poultices: Where needed, provide a paste or slurry made with absorbent material or powder-inert clay, such as kaolin or sepiolite, diatomaceous earth (fuller's earth), or cellulose products such as pulp cellulose or shredded paper that is mixed with a cleaning solution (a liquid reagent such as water, organic solvent, among others).

F. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces,

including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.

G. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed in accordance with "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.

H. Remove minor stains (cuprous, ferrous, etc.) if any.

I. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.6 WATER-CLEANING TYPE

A. Water Application Methods:

1. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least **6 inches (150 mm)** from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.

B. Cold-Water Soak:

1. Apply cold water by intermittent spraying to keep surface moist.
2. Use perforated hoses or other means that apply a fine water mist to entire surface being cleaned.
3. Apply water in cycles of [**five minutes**] on and [**20 minutes**] off.
4. Continue spraying [**until surface encrustation has softened enough to permit its removal by water wash, as indicated by cleaning tests**][**for 72 hours**].
5. Remove soil and softened surface encrustation from surface with cold water applied by low-pressure spray.

C. Cold-Water Wash: Use cold water applied by [**low**][**medium**][**high**]-pressure spray.

D. Hot-Water Wash: Use hot water applied by [**low**][**medium**][**high**]-pressure spray.

E. Steam Cleaning: Apply steam at very low pressures not exceeding [**30 psi (207 kPa)**][**80 psi (550 kPa)**]. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.

3.7 CHEMICAL-CLEANING TYPE

A. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces in accordance with chemical-cleaner manufacturer's written instructions; use brush[**or spray**] application.[**Do not spray apply at pressures exceeding 50 psi (345 kPa).**] Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

1. Consult with cleaning product manufacturer to verify what products require pre-wetting of substrate before cleaner application.

B. Dilute chemical cleaners with water when required to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.

C. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.

1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.

D. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

E. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.

F. Nonacidic Gel Chemical Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply gel cleaner in **1/8-inch (3-mm)** thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively, so area is uniformly covered with fresh cleaner and dwell time is uniform throughout area being cleaned.
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**].
4. Remove bulk of gel cleaner.
5. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
6. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

G. Nonacidic Liquid Chemical Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of 2 to 3 minutes**].
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

H. Mild-Acid Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of 2 to 3 minutes**].
4. Rinse with cold water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

I. Acidic Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of 2 to 3 minutes**].
4. Rinse with cold water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil. Rinse until all foaming, if any, stops and suds disappear.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

J. One-Part Limestone Chemical Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**].
4. Immediately repeat application of one-part limestone cleaner as indicated above over the same area.
5. Rinse with [**cold**][**hot**] water applied by medium-pressure spray to remove chemicals and soil.

K. Two-Part Chemical Cleaning: .

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply alkaline prewash cleaner to surface by brush or roller.
3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer unless otherwise indicated.
4. Rinse with [**cold**][**hot**] water applied by medium-pressure spray to remove chemicals and soil.
5. Apply acidic afterwash cleaner to surface[**in two applications**], while surface is still wet, using[**low-pressure spray equipment,**] deep-nap roller or soft-fiber brush. Let neutralizer remain on surface for period recommended in writing by manufacturer unless otherwise indicated.
6. Rinse with cold water applied by medium-pressure spray to remove chemicals and soil.[**Rinse until surface reaction value is between pH 5 and pH 9 according to pH-measuring paper, pen, or indicator solution.**]
7. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage [**paint-remover manufacturer's and**] chemical-cleaner manufacturer's factory-authorized service representatives for consultation and Project-site inspection, to perform preconstruction product testing, and provide on-site assistance as directed by the Owner. Have [**paint-remover manufacturer's and**] chemical-cleaner manufacturer's factory-authorized service representatives visit Project site not less than [**once**][**twice**] to observing progress and quality of the work.

3.9 FINAL CLEANING

A. Clean adjacent nonmasonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.

B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

C. Remove masking materials, leaving no residues that could trap dirt.

D. Clean landscaping areas of debris.

3.10 PROTECTION

A. Provide final protection and maintain conditions in a manner as directed by the Owner, which ensures cleaning Work without being soiled at time of substantial completion.

END OF SECTION 04 01 00 00

Task	Specification	Specification Description
04 01 20 00	04 01 00 00	Masonry Cleaning
04 01 20 41	04 01 00 00	Masonry Cleaning

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SECTION 04 01 20 51 - BRICK MASONRY REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Masonry materials.
2. Mortar materials.
3. Manufactured repair materials.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 040110 "Masonry Cleaning" for cleaning and paint removal existing masonry.
3. Section 040120.64 "Brick Masonry Repointing" for repointing existing brickwork.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and sealant-joint preparation for repaired masonry.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed.

B. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. Remove: Detach items from existing construction and legally dispose of off-site unless indicated to be removed and salvaged or removed and reinstalled.

D. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to the Owner or storage, as directed by the Owner.

E. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage; prepare for reuse; and reinstall where indicated.

F. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.

G. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of bricks to freezing and thawing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to brick masonry repair including, but not limited to, the following:

a. Verify brick masonry repair specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Cleaning types and cleaning methods.
d. Quality-control program.
e. Review cleaning program.
f. Coordination with building occupants.
g. Protection and barriers for the public.

1.4 SEQUENCING AND SCHEDULING

A. Order sand[**and gray portland cement**] for colored mortar immediately after approval of [**Samples**][**mockups**]. Take delivery of and store at Project site enough quantity to complete Project.

B. Work Sequence: Perform brick masonry repair work in the following sequence, which includes work specified in this and other Sections:

1. Remove plant growth.
2. Inspect masonry for open mortar joints and point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint.
4. Clean masonry.
5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
6. Repair masonry, including replacing existing masonry with new masonry materials.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.

C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in bricks in accordance with "Brick Masonry Patching" Article. Patch holes in mortar joints according to Section 040120.64 "Brick Masonry Repointing."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include recommendations for product application and use.
3. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of replacement bricks on the structure, showing relation of existing and new or relocated units.
2. Show provisions for expansion joints or other sealant joints.
3. Show provisions for flashing, lighting fixtures, conduits, and weep holes as required.
4. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of

each point of contact or anchorage.

C. Samples for Initial Selection: For the following:

1. Colored Mortar: Submit sets of mortar that will be left exposed in the form of sample mortar strips, **6 inches (150 mm)** long by [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**] wide, set in aluminum or plastic channels.

   a. Have each set contain a close color range of at least [**three**][**six**] Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
   b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.

2. Sand Types Used for Mortar: Minimum **8 oz. (240 mL)** of each in plastic screw-top jars.
3. Patching Compound: Submit sets of patching compound Samples in the form of plugs (patches in drilled holes) in sample units of masonry representative of the range of masonry colors on the building.

   a. Have each set contain a close color range of at least [**three**][**six**] Samples of different mixes of patching compound that matches the variations in existing masonry when cured and dry.

4. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For the following:

1. Each type of brick unit to be used for replacing existing units. Include sets of Samples to show the full range of shape, color, and texture to be expected. For each brick type, provide straps or panels containing at least four bricks. Include multiple straps for brick with a wide range.
2. Each type of patching compound in the form of briquettes, at least **3 inches (75 mm)** long by **1-1/2 inches (38 mm)** wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.
3. Accessories: Each type of accessory and miscellaneous support.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**brick masonry repair specialist**][**including field supervisors and workers**][**and**][**testing service**].

B. Preconstruction Test Reports: For [**existing bricks and mortar**][**and**][**replacement bricks**].

C. Quality-control program.

1.7 QUALITY ASSURANCE

A. Brick Masonry Repair Specialist Qualifications: Engage an experienced brick masonry repair firm to perform Work of this Section. Firm is to have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repair work.

1. Field Supervision: Brick masonry repair specialist firm is to maintain experienced full-time supervisors on Project site during times that brick masonry repair work is in progress.

2. Brick Masonry Repair Workers: When bricks are being patched, at least one worker per crew should be trained and certified by manufacturer of patching compound to apply its products performing the work of brick repairs.

B. Brick-Cleaning Specialist Firms: A firm that provides masonry cleaning, including masonry cleaners that have been used for similar applications with successful results, and is manufacturer authorized for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

C. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

1.8 MOCKUPS

A. Prepare mockups of brick masonry repair to demonstrate aesthetic effects and to set quality standards for materials and execution, and for fabrication and installation, as directed by the Owner.

1. Masonry Repair: Prepare sample areas for each type of masonry repair work performed. If not otherwise indicated, size each mockup not smaller than two adjacent whole units or approximately **48 inches (1200 mm)** in least dimension. Construct sample areas in locations in existing walls, as directed by the Owner. Demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:

   a. Replacement: [**Four**] brick units replaced.
   b. Patching: Three small holes [**at least 1 inch (25 mm) in diameter**][**as directed**] for each type of brick indicated to be patched.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, as directed by the Owner.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on brick masonry as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Replacement Brick: Test each proposed type of replacement brick in accordance with sampling and testing methods in ASTM C67/C67M for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction).
3. Existing Brick: Test each type of existing brick indicated for replacement in accordance with testing methods in ASTM C67/67M for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove [**five**] existing units from locations, as directed by the Owner. Take testing samples from these units.
4. Existing Mortar: Test in accordance with ASTM C1324, modified as directed by the Owner, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.
5. Temporary Patch: As directed by the Owner, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver bricks to Project site strapped together in suitable packs or pallets or in heavy-duty cartons and protected against impact and chipping.

B. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.

E. Store sand where grading and other required characteristics can be maintained and contamination avoided.

F. Handle bricks to prevent overstressing, chipping, defacement, and other damage.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed in accordance with product manufacturers' written instructions and specified requirements.

B. Temperature Limits: Repair brick masonry only when air temperature is between **40 and 90 deg F (4 and 32 deg C)** and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.

C. Cold-Weather Requirements: Comply with the following procedures for masonry repair unless otherwise indicated:

1. When air temperature is below **40 deg F (4 deg C)**, heat mortar ingredients, masonry repair materials, and existing masonry walls to produce temperatures between **40 and 120 deg F (4 and 49 deg C)**.
2. When mean daily air temperature is below **40 deg F (4 deg C)**, provide enclosure and heat to maintain temperatures above **32 deg F (0 deg C)** within the enclosure for seven days after repair.

D. Hot-Weather Requirements: Protect masonry repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of **90 deg F (32 deg C)** and above unless otherwise indicated.

E. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**brick units**][**cementitious mortar components**][**and**][**sand**] from single [**source**][**producer**][**or**][**manufacturer**].

B. For [**exposed masonry units**][**and**][**cementitious mortar components**], obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.3 MASONRY MATERIALS

A. Masonry Materials: Face brick, required to complete brick masonry repair work.

1. Brick Matching Existing: Units with colors, color variation within units, surface texture, size, and shape that match existing brickwork and with physical properties [**within 10 percent of those determined from preconstruction testing of selected existing units.**][**as listed below:**]

a. Physical Properties: In accordance with ASTM C67/C67M.
b. For existing brickwork that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range and variation rather than brick that matches an individual color within that range.

2. Brick Matching Architect's Sample: Units with colors, color variation within units, surface texture, and physical properties that match Architect's sample. Match existing units in size and shape, as directed by the Owner.

a. Physical Properties: In accordance with ASTM C67C67M.
b. For Architect's sample that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range rather than brick that matches an individual color within that range.

3. Special Shapes:

a. Provide molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.
b. Provide specially ground units, shaped to match patterns, for arches and where indicated.
c. Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are unacceptable procedures for fabricating special shapes.

4. Tolerances as Fabricated: [**In accordance with tolerance requirements in ASTM C216, Type FBX**][**In accordance with tolerance requirements in ASTM C216, Type FBS**].

B. Building Brick: ASTM C62, of same vertical dimension as face brick, for masonry work concealed from view.

1. Grade SW where in contact with earth.
2. [**Grade SW or Grace MW**][**Grade SW, Grade MW, or Grade NW**] for concealed backup.

2.4 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white[**or gray, or both**] where required for color matching of mortar.

1. Provide cement containing not more than 0.60 percent total alkali when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cemex S.A.B. de C.V.**]
b. [**Heidelberg Materials**]
c. [**Holcim (US) Inc**]
d. [**Quikrete; The QUIKRETE Companies, LLC**]

D. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Holcim (US) Inc**]

E. Mortar Sand: ASTM C144.

1. Exposed Mortar: Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
2. Colored Mortar: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.

F. Mortar Pigments: ASTM C979/C979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Davis Colors**]
b. [**Lanxess Corporation**]
c. [**Solomon Colors Inc.**]

G. Water: Potable.

2.5 MANUFACTURED REPAIR MATERIALS

A. Brick Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching brick masonry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cathedral Stone Products, Inc.**]
b. [**Conproco Corporation**]
c. [**Edison Coatings, Inc.**]

2. Use formulation that is vapor and water permeable (equal to or more than the brick), exhibits low shrinkage, has lower modulus of elasticity than bricks being repaired, and develops high bond strength to all types of masonry.
3. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
4. Formulate patching compound in colors and textures to match each brick being patched. Provide [**sufficient number of**][**no fewer than three**] colors to enable matching of the color, texture, and variation of each unit.

2.6 ACCESSORY MATERIALS

A. Setting Buttons and Shims: Resilient plastic, nonstaining to masonry, sized to suit joint thicknesses and bed depths of bricks, less the required depth of pointing materials unless removed before pointing.

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

C. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer in accordance with [**MPI #23 (surface-tolerant, anticorrosive metal primer)**][**or**][**SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating**].

1. Surface Preparation: Use coating requiring no better than [**SSPC-SP 2, "Hand Tool Cleaning"**][**SSPC-SP 3, "Power Tool Cleaning"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"**] surface preparation in accordance with manufacturer's literature or certified statement.
2. VOC Limit: Use coating with a VOC content of [**400 g/L (3.3 lb/gal.)**] or less.

D. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Minimal possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could leave residue on surfaces.

2.7 MORTAR MIXES

A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

B. Colored Mortar: Produce mortar of color required by using specified ingredients, as directed by the Owner.

1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.

C. Do not use admixtures in mortar unless otherwise indicated.

D. Mixes: Mix mortar materials in the following proportions:

1. Rebuilding (Setting) Mortar by Volume: ASTM C270, Proportion Specification, [**1 part portland cement, 1 part lime, and 6 parts sand**].
2. Rebuilding (Setting) Mortar by Type: ASTM C270, Proportion Specification, [**Type N**] unless otherwise indicated; with cementitious material limited to [**portland cement and lime**][**masonry cement**][**or**][**mortar cement**].
3. Rebuilding (Setting) Mortar by Property: ASTM C270, Property Specification, [**Type N**] unless otherwise indicated; with cementitious material limited to [**portland cement and lime**][**masonry cement**][**or**][**mortar cement**].
4. Pigmented, Colored Mortar: Add mortar pigments to produce exposed, setting (rebuilding) mortar of colors required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate conditions with specialist present, for compliance with approved mockup requirements for brick units, repair methods, products, and other conditions affecting performance of the Work.

3.2 PREPARATION

A. General: Comply with each manufacturer's written instructions for protecting people, motor vehicles, surrounding buildings, masonry areas not to be cleaned, nonmasonry surfaces, landscaping, equipment, and other surfaces that could be injured or harmed by such Work.

1. Provide temporary protective covers over pedestrian walkway areas and at points of entrance and exit for people, motor vehicles, and equipment that must remain during duration of repairing procedures.
2. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant.
3. Temporarily protect all open joints to prevent intrusion of washing waters into the wall structure or building interior.
4. Remove all extraneous items no longer in use on face of surface unless indicated to remain, as directed by the Owner.

3.3 PROTECTION

A. Prevent mortar from staining face of surrounding masonry and other surfaces.

1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

3.4 MASONRY REPAIR, GENERAL

A. Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from [**20 ft. (6 m)**][**50 ft. (15 m)**] away, as directed by the Owner.

3.5 ABANDONED ANCHOR REMOVAL

A. Remove abandoned anchors, brackets, wood nailers, and other extraneous items [**no longer in use unless indicated to remain**][**indicated to be removed**].

1. Remove items carefully to avoid spalling or cracking masonry.
2. If an item cannot be removed without damaging surrounding masonry, review, as directed by the Owner. Do the following where directed:

a. Cut or grind off item approximately [**3/4 inch (20 mm)**] beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
b. Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.

3. Patch hole where each item was removed unless directed to remove and replace bricks.

3.6 BRICK REMOVAL AND REPLACEMENT

A. At locations indicated, remove bricks that are damaged, spalled, or deteriorated[**or are to be reused**]. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.

1. When removing single bricks, remove material from center of brick and work toward outside edges.

B. Support and protect remaining masonry that surrounds removal area.

C. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.[**Coordinate with new flashing, reinforcement, and lintels, which are specified in other Sections.**]

D. Notify the Owner of unforeseen detrimental conditions, including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.

E. Remove in an undamaged condition as many whole bricks as possible.

1. Remove mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.

2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
3. Store brick for reuse. Store off ground, on skids, and protected from weather.
4. Deliver cleaned brick not required for reuse to the Owner, as directed by the Owner.

F. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for brick replacement.

G. Replace removed damaged brick with other removed brick in good condition, where possible, [**or with new brick**]matching existing brick. Do not use broken units unless they can be cut to usable size.

H. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.

1. Maintain joint width for replacement units to match existing joints.
2. Use setting buttons or shims to set units accurately spaced with uniform joints.

I. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter ends with enough mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C67/C67M initial rates of absorption (suction) of more than **30 g/30 sq. in. per min. (30 g/194 sq. cm per min.)** Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.

1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
2. Rake out mortar used for laying brick before mortar sets in accordance with Section 040120.64 "Brick Masonry Repointing." Point at same time as repointing of surrounding area.
3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.

J. Curing: Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.

1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.7 PAINTING STEEL UNCOVERED DURING THE WORK

A. Notify the Owner if steel is exposed during masonry removal. Where Architect determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Surface Preparation: Remove paint, rust, and other contaminants in accordance with [**SSPC-SP 2, "Hand Tool Cleaning"**][**SSPC-SP 3, "Power Tool Cleaning"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"**], as applicable to comply with paint manufacturer's recommended preparation.
2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than [**1/16 inch (1.6 mm)**], notify the Owner before proceeding.

3.8 BRICK MASONRY PATCHING

A. Patch the following bricks unless another type of repair or replacement is indicated:

1. Bricks indicated to be patched.
2. Bricks with holes.
3. Bricks with chipped edges or corners.[**Patch chipped edges or corners measuring more than 3/4 inch (19 mm) in least dimension.**]
4. Bricks with small areas of deep deterioration.[**Patch deep deteriorations measuring more than 3/4 inch (19 mm) in least dimension and more than 1/4 inch (6 mm) deep.**]

B. Remove and replace existing patches [**where indicated**][**unless otherwise indicated or as directed by the Owner**].

C. Patching Bricks:

1. Remove loose material from masonry surface. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least [**1/4 inch (6 mm)**] thick, but not less than recommended in writing by patching compound manufacturer.
2. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of brick.
3. Mix patching compound in individual batches to match each unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
4. Rinse surface to be patched and leave damp, but without standing water.
5. Brush-coat surfaces with slurry coat of patching compound in accordance with manufacturer's written instructions.
6. Place patching compound in layers as recommended in writing by patching compound manufacturer, but not less than **1/4 inch (6 mm)** or more than **2 inches (50 mm)** thick. Roughen surface of each layer to provide a key for next layer.
7. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of brick. Shape and finish surface before or after curing, as determined by testing, to best match existing brick.
8. Keep each layer damp for 72 hours or until patching compound has set.
9. Remove and replace patches with hairline cracks or that show separation from brick at edges, and those that do not match adjoining brick in color or texture.

3.9 FINAL CLEANING

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

B. Clean adjacent nonmasonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Remove masking materials, leaving no residues that could trap dirt.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: The Owner will engage a qualified testing agency to perform tests and inspections, as directed by the Owner. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.

B. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed, as directed by the Owner.

C. Notify [**inspectors**][**and**][**the Owner**] in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until [**inspectors**][**and**][**the Owner**] have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

3.11 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property.

B. Masonry Waste: Remove masonry waste and legally dispose of off the Owner property, as directed by the Owner.

END OF SECTION 04 01 20 51

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Task	Specification	Specification Description
04 01 20 51	03 01 30 00	Maintenance of Cast-in-Place Concrete
04 01 20 51	04 01 00 00	Masonry Cleaning

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SECTION 04 01 20 91 - BRICK MASONRY REPOINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mortar materials.
2. Mortar mixes.

B. Related Requirements:

1. Section 012100 "Allowances" for brick repointing allowances.
2. Section 012200 "Unit Prices" for brick repointing unit prices. Indicate the percentage, if any, by which actual quantities may deviate upward or downward from estimated quantities before the unit price may be adjusted by a change order.
3. Section 040110 "Masonry Cleaning" for cleaning and paint removal from both clay masonry and stone.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**] <**Insert range of values**>.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1. Review methods and procedures related to repointing brick masonry including, but not limited to, the following:

a. Verify brick masonry repointing specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Quality-control program.
d. Coordination with building occupants.
e. <**Insert agenda items**>.

1.4 SEQUENCING AND SCHEDULING

A. Order sand[**and gray portland cement**] for pointing mortar immediately after approval of [**Samples**] [**mockups**]. Take delivery of and store at Project site enough quantity to complete Project.

B. Work Sequence: Perform brick masonry repointing Work in the following sequence, which includes Work specified in this and other Sections:

1. Remove plant growth.

2. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint.
4. Clean masonry.
5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
6. Repair masonry, including replacing existing masonry with new masonry materials.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.

C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in bricks in accordance with Section 040120.63 "Brick Masonry Repair." Patch holes in mortar joints in accordance with "Repointing" Article.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include recommendations for product application and use.
3. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of repointing work on the structure.
2. Show provisions for expansion joints or other sealant joints.
3. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.

C. Samples for Initial Selection: For the following:

1. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches (150 mm) long by [**1/4 inch (6 mm)**] [**1/2 inch (13 mm)**] wide, set in aluminum or plastic channels.

    a. Have each set contain a close color range of at least [**three**] [**six**] **<Insert number>** Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
    b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.

2. Sand Type Used for Pointing Mortar: Minimum 8 oz. (240 mL) of each in plastic screw-top jars.
3. Sealant materials.
4. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For the following:

1. Each type, color, and texture of pointing mortar in the form of sample mortar strips, 6 inches (150 mm) long by [**1/4 inch (6 mm)**] [**1/2 inch (13 mm)**] wide, set in aluminum or plastic channels.

    a. Include with each Sample a list of ingredients with proportions of each. Identify sources, both supplier and quarry, of each type of sand and brand names of cementitious materials and pigments if any.

2. Sealant materials.
3. Accessories: Each type of accessory and miscellaneous support.

1.6 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For existing bricks and mortar.

B. Quality-control program.

C. Qualification Statements: For [**brick masonry repointing specialist**] [**field supervisors and workers**] [**and**] [**testing service**].

1.7 QUALITY ASSURANCE

A. Brick Masonry Repointing Specialist Qualifications: Engage an experienced brick masonry repointing firm to perform work of this Section. Firm is to have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repointing work.

1. Field Supervision: Brick masonry repointing specialist firms are to maintain experienced full-time supervisors on Project site during times that brick masonry repointing work is in progress.

B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

1.8 MOCKUPS

A. Prepare mockups of brick masonry repointing to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Repointing: Rake out joints in two separate areas[**, each approximately 36 inches (900 mm) high by 48 inches (1200 mm) wide**] [**as indicated on Drawings**] <**Insert dimensions**> for each type of repointing required, and repoint one of the areas.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**Owner will engage**] [**Engage**] a qualified testing agency to perform preconstruction testing on masonry units as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Existing Brick: Test each type of existing brick indicated for repointing in accordance with testing methods in ASTM C67/C67M for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove [**five**] <**Insert number**> existing units from locations designated by Architect. Take testing samples from these units.
3. Existing Mortar: Test in accordance with ASTM C1324, modified as agreed by testing service and Architect for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.
4. Temporary Patch: As directed by Architect, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.

D. Store sand where grading and other required characteristics can be maintained and contamination avoided.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed in accordance with product manufacturers' written instructions and specified requirements.

B. Temperature Limits: Repoint mortar joints only when air temperature is between 40 and 90 deg F (4 and 32 deg C) and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.

C. Cold-Weather Requirements: Comply with the following procedures for mortar-joint pointing unless otherwise indicated:

1. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients and existing masonry walls to produce temperatures between 40 and 120 deg F (4 and 49 deg C).
2. When mean daily air temperature is below 40 deg F (4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for seven days after pointing.

D. Hot-Weather Requirements: Protect mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of material for repointing brick masonry (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white[**or gray, or both**] where required for color matching of mortar.

1. Provide cement containing not more than 0.60 percent total alkali when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Masonry Cement: ASTM C91/C91M.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

D. Mortar Cement: ASTM C1329/C1329M.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

E. Mortar Sand: ASTM C144.

1. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
2. Color: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.

F. Mortar Pigments: ASTM C979/C979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

G. Water: Potable.

2.3 MORTAR MIXES

A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

1. Mixing Pointing Mortar: Thoroughly mix cementitious materials and sand together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this dampened condition for 15 to 30 minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one hour of final mixing; do not retemper or use partially hardened material.

B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's written approval.

1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.

C. Do not use admixtures in mortar unless otherwise indicated.

D. Mixes: Mix mortar materials in the following proportions:

1. Pointing Mortar by Volume: ASTM C270, Proportion Specification, [**1 part portland cement, 1 part lime, and 6 parts sand**] <**Insert proportions**>.[**Add mortar pigments to produce mortar colors required.**]
2. Pointing Mortar by Type: ASTM C270, Proportion Specification, [**Type N**] <**Insert Type**> unless otherwise indicated; with cementitious material limited to [**portland cement and lime**] [**masonry cement**] [**or**] [**mortar cement**].[**Add mortar pigments to produce mortar colors required.**]
3. Pointing Mortar by Property: ASTM C270, Property Specification, [**Type N**] <**Insert Type**> unless otherwise indicated; with cementitious material limited to [**portland cement and lime**] [**masonry cement**] [**or**] [**mortar cement**].[**Add mortar pigments to produce mortar colors required.**]

2.4 ACCESSORY MATERIALS

A. Sealant Materials:

1. Sealant manufacturer's standard elastomeric sealant(s) of base polymer and characteristics in accordance with applicable requirements in Section 079200 "Joint Sealants."

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

PART 3 - EXECUTION

3.1 PROTECTION

A. Prevent mortar from staining face of surrounding masonry and other surfaces.

1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
2. Keep wall area wet below pointing work to discourage mortar from adhering.
3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

B. Remove[**gutters and**] downspouts and associated hardware adjacent to masonry and store during masonry repointing. Reinstall when repointing is complete.

1. Provide temporary rain drainage during work to direct water away from building.

3.2 MASONRY REPOINTING, GENERAL

A. Appearance Standard: Repointed surfaces are to have a uniform appearance as viewed from [**20 ft. (6 m)**] [**50 ft. (15 m)**] <**Insert distance**> away by Architect.

3.3 REPOINTING

A. Rake out and repoint joints to the following extent:

1. All joints in areas indicated.
2. Joints indicated as sealant-filled joints.
3. Joints at locations of the following defects:

a. Holes and missing mortar.
b. Cracks that can be penetrated 1/4 inch (6 mm) or more by a knife blade 0.027 inch (0.7 mm) thick.
c. Cracks [**1/16 inch (1.6 mm)**] [**1/8 inch (3 mm)**] <**Insert dimension**> or more in width and of any depth.
d. Hollow-sounding joints when tapped by metal object.
e. Eroded surfaces 1/4 inch (6 mm) deep or deeper.
f. Deterioration to point that mortar can be easily removed by hand, without tools.
g. Joints filled with substances other than mortar.

B. Do not rake out and repoint joints where not required.

C. Rake out joints as follows, in accordance with procedures demonstrated in approved mockup:

1. Remove mortar from joints to depth of [**joint width plus 1/8 inch (3 mm)**] [**2 times joint width**] [**2-1/2 times joint width**] [**not less than 1/2 inch (13 mm)**] [**not less than 3/4 inch (20 mm)**] [**and**] [**not less than that required to expose sound, unweathered mortar**] <**Insert requirement**>. Do not remove unsound mortar more than [**2 inches (50 mm)**] <**Insert dimension**> deep; consult Architect for direction.
2. Remove mortar from brick and other masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
3. Do not spall edges of brick or other masonry units or widen joints. Replace or patch damaged brick or other masonry units as directed by Architect.

D. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.

E. Pointing with Mortar:

1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than [**3/8 inch (9 mm)**] <**Insert dimension**> until a uniform depth is formed. Fully compact each layer, and allow it to become thumbprint hard before applying next layer.
3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than [**3/8 inch (9 mm)**] <**Insert dimension**>. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.

6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

F. Pointing with Sealant: Comply with Section 079200 "Joint Sealants" and as follows:

1. After raking out, keep joints dry and free of mortar and debris.
2. Clean and prepare joint surfaces.[**Prime joint surfaces unless sealant manufacturer recommends against priming.**] Do not allow primer to spill or migrate onto adjoining surfaces.
3. Fill sealant joints with specified joint sealant.

a. Install cylindrical sealant backing beneath the sealant. Where space is insufficient for cylindrical sealant backing, install bond-breaker tape.
b. Install sealant using only proven installation techniques that ensure that sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding masonry and matching the contour of adjoining mortar joints.
c. Install sealant as recommended in writing by sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead:

1) Fill joints to a depth equal to joint width, but not more than 1/2 inch (13 mm) deep or less than 1/4 inch (6 mm) deep.

d. Tool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant from surfaces adjacent to joint.
e. Do not allow sealant to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces, particularly rough textures. Remove excess and spillage of sealant promptly as the work progresses. Clean adjoining surfaces by the means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

G. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

3.4 FINAL CLEANING

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

B. Clean adjacent nonmasonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Remove masking materials, leaving no residues that could trap dirt.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.

B. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

C. Notify [**inspectors**] [**and**] [**Architect's Project representatives**] in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until [**inspectors**] [**and**] [**Architect's Project representatives**] have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

END OF SECTION 04 01 20 91

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Task	Specification	Specification Description
04 01 20 91	04 01 00 00	Masonry Cleaning
04 01 50 00	04 01 00 00	Masonry Cleaning
04 01 50 52	04 01 00 00	Masonry Cleaning
04 05 13 26	04 20 00 00	Unit Masonry
04 05 16 26	04 20 00 00	Unit Masonry
04 05 19 13	04 20 00 00	Unit Masonry
04 05 19 16	04 20 00 00	Unit Masonry
04 05 23 13	04 20 00 00	Unit Masonry
04 05 23 16	01 11 19 00	No Specification Required
04 05 23 16	07 62 00 00	Sheet Metal Flashing And Trim

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SECTION 04 20 00 00 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Clay masonry units.
3. Structural clay facing tile.
4. Fireplace and chimney lining units.
5. Lintels
6. Mortar and grout materials
7. Reinforcement.
8. Ties and anchors.
9. Embedded flashing.
10. Accessories.
11. Mortar and grout mixes.

B. Products Installed, but Not Furnished, under This Section:

1. Cast-stone trim in unit masonry.
2. Stone trim units in unit masonry.
3. Steel lintels in unit masonry.
4. Steel shelf angles for supporting unit masonry.
5. Cavity wall insulation adhered to masonry backup.

C. Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 019119.43 "Exterior Enclosure Commissioning."
3. Section 033000 "Cast-in-Place Concrete" for [**installing**] dovetail or channel slots for masonry-veneer anchors.
4. Section 042300 "Glass Unit Masonry" for glass block.
5. Section 042613 "Masonry Veneer" for unit masonry set as veneer.
6. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
7. Section 044313.13 "Anchored Stone Masonry Veneer" for thin stone trim set as anchored veneer.
8. Section 044313.16 "Adhered Stone Masonry Veneer" for thin stone trim set as adhered veneer.
9. Section 047200 "Cast Stone Masonry" for cast stone trim units.
10. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
11. Section 071900 "Water Repellents" for water repellents topically applied to unit masonry assemblies.
12. Section 072100 "Thermal Insulation" for cavity wall insulation.
13. Section 076200 "Sheet Metal Flashing and Trim" for [**exposed**] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
14. Section 089516 "Wall Vents" for wall vents (brick vents).
15. Section 096313 "Brick Flooring" for interior brick flooring.
16. Section 096313.35 "Chemical-Resistant Brick Flooring" for chemical-resistant, interior brick flooring.
17. Section 097519 "Stone Trim" for interior stone window stools.
18. Section 321400 "Unit Paving" for exterior unit masonry paving.

19. Section 323223 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Exposed: Weather-exposed side of a constructed wall.

C. Reinforced Masonry: Masonry containing reinforcing steel within grouted cells.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI PRC 315R. [**Indicate elevations of reinforced walls.**]
3. Lintel design and types required.
4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Acoustical CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Rigid, Cellular Thermal Insulation CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Low carbon CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
8. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
9. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
10. Glazed Structural Clay Facing Tile: [**Small-scale units**][**Full-size units, minimum of five**] .
11. Colored Mortar: Full range of manufacturer's standard colors.
12. Aggregate for Mortar: Range of aggregate colors for colored-aggregate mortar.
13. Weep/cavity vents.

D. Samples for Verification: For each type and color of the following:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Acoustical CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Rigid, Cellular Thermal Insulation CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Low carbon CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .

8. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
9. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
10. Glazed Structural Clay Facing Tile: [**Small-scale units**][**Full-size units, minimum of five**] .
11. Colored mortar.
12. Weep/cavity vents.
13. Special Masonry Shapes: One of each unique shape.
14. Pigmented Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
15. Colored-Aggregate Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
16. Cavity drainage material.
17. Accessories embedded in masonry.

E. Delegated Design Submittals: For [**masonry anchors and ties**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

1.5 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only.

B. Material Certificates: For each type of the following:

1. Masonry units.

a. Include [**data on material properties**][**material test reports substantiating compliance with requirements**] .
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M [**or a list of addresses of buildings in Project's area where proposed brick has been used**

successfully and with a history of durability] .

e. For masonry units [**used in structural masonry**] , include data and calculations establishing average net-area compressive strength of units.

2. Integral water repellent used within CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar [**and grout**] . Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

D. Qualification Statements: For testing agency.

E. Delegated Design Engineer Qualifications: For [**masonry anchors and ties**].

F. Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements for [**cold**][**and**][**hot**] weather.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 MOCKUPS

A. Sample Panel Mockups: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**] high [**by full thickness**] .
2. Build sample panels facing south.
3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of panels with masonry cleaner indicated.

5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities, as directed by the Owner.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels, as directed by the Owner.

B. Wall Mockups: Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**and**][**to set quality standards for installation**] . [**See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups.**]

1. Build mockup [**as indicated on Drawings**] .
2. Build mockups for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**] high by full thickness, including face and backup wythes and accessories.

    a. Include a sealant-filled joint at least **16 inches (406 mm)** long in [**each**][**exterior wall**] mockup.
    b. Include lower corner of window opening [**framed with stone trim**] at upper corner of exterior wall mockup. Make opening approximately **12 inches (305 mm)** wide by **16 inches (406 mm)** high.
    c. Include through-wall flashing installed for a **24-inch (610-mm)** length in corner of exterior wall mockup approximately **16 inches (406 mm)** down from top of mockup, with a **12-inch (305-mm)** length of flashing left exposed to view (omit masonry above half of flashing).
    d. Include wall substrate and cavity materials, veneer anchors, flashing [**cavity drainage material**], and weep holes in exterior masonry-veneer wall mockup.
    e. Include specified unit masonry on one face of interior unit masonry wall mockup.

3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of mockups with masonry cleaner as indicated.
5. Protect accepted mockups from the elements with weather-resistant membrane.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
7. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of **24 inches (610 mm)** down both sides of walls, and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of **24 inches (610 mm)** down face next to unconstructed wythe, and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**exposed masonry units**][**cementitious mortar components**][**and**][**mortar aggregate**] from single [**source**][**producer**][**or**][**manufacturer**] .

B. For [**exposed masonry units**][**and**][**cementitious mortar components**] , obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Masonry to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] .

B. Provide [**structural**] unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 402/602.
2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 402/602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work [**and will be within 20 ft. (6 m) vertically and horizontally of a walking surface**] .

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

A. Regional Materials: Verify CMUs are manufactured within **100 miles (160 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify CMUs are manufactured within **500 miles (800 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide [**square-edged**][**bullnose**] units for outside corners unless otherwise indicated.

D. CMUs: ASTM C90, [**normal weight**][**medium weight**][**lightweight**][**unless otherwise indicated**] .

1. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
2. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
3. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

E. Architectural CMUs: ASTM C90, [**normal-weight**][**medium-weight**][**lightweight**] architectural units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Angelus Block Co., Inc.**]
    b. [**Echelon Masonry, an Oldcastle APG brand**]
    c. [**York Building Products**]

2. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
3. Pattern and Texture: [**Standard pattern, ground-face finish**][**Standard pattern, split-face finish**][**Standard pattern, split-ribbed finish**][**Scored vertically to appear square in stacked bond, standard finish**][**Triple scored vertically to appear as soldier courses in stacked bond, standard finish**] [**Match Architect's samples.**]
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.

F. Prefaced CMUs: ASTM C90, lightweight, with manufacturer's standard smooth resinous facing complying with ASTM C744.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Echelon Masonry, an Oldcastle APG brand**]
    b. [**York Building Products**]

2. Composition: [**Hollow**][**Solid**] units.
3. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.6-mm-)** wide returns of facing to create **1/4-inch- (6.2-mm-)** wide mortar joints with modular coursing.
4. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

G. Acoustical CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] sound-absorbing units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Acme Brick Company**]
    b. [**Echelon Masonry, an Oldcastle APG brand**]
    c. [**RPG Acoustical Systems, Inc.**]
    d. [**Sound Seal**]

2. Surface Characteristics: [**Slotted**][**Textured**] .
3. Cavity Fill: [**Fibrous filler**][**Galvanized steel septum**][**Unfilled**] .

4. Sound Transmission Classification (STC): In accordance with ASTM E90 and ASTM E413.
5. Noise Reduction Coefficient (NRC): In accordance with ASTM C423 and ASTM E795.

H. Rigid, Cellular Thermal Insulation CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units containing rigid, specially shaped, molded-polystyrene insulation complying with ASTM C578, Type I, designed for installing in cores of CMUs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Concrete Block Insulating Systems**]
    b. [**Echelon Masonry, an Oldcastle APG brand**]
    c. [**Shelter Enterprises Inc.**]
    d. [**York Building Products**]

2. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

I. Low-Carbon CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units with low embodied carbon.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CarbonBuilt**]
    b. [**CarbonCure**]
    c. [**CarbonKind**]
    d. [**CarbonX**]
    e. [**Pozzotive (Glenwood Mason Supply)**]

2. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.5-mm-)** wide returns of facing to create **1/4-inch- (6-mm-)** wide mortar joints with modular coursing.
3. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

J. Concrete Building Brick: ASTM C55, [**normal-weight**][**medium-weight**][**lightweight**] solid units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Acme Brick Company**]
    b. [**Belden Brick Company (The)**]
    c. [**Bilco Brick Company**]
    d. [**Echelon Masonry, an Oldcastle APG brand**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches**

(70 mm)][3-5/8 inches (92 mm)] high by 7-5/8 inches (194 mm) long.

K. Concrete Facing Brick: ASTM C1634, [**normal-weight**][**medium-weight**][**lightweight**] solid units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Brick Company**]
b. [**Belden Brick Company (The)**]
c. [**Bilco Brick Company**]
d. [**Echelon Masonry, an Oldcastle APG brand**]
e. [**Westbrook Concrete Block Co., Inc.**]

2. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by [2-1/4 inches (57 mm)][2-3/4 inches (70 mm)][3-5/8 inches (92 mm)] high by [7-5/8 inches (194 mm)][11-5/8 inches (295 mm)][15-5/8 inches (397 mm)] long.
3. Texture: [**Smooth-face**][**Split-face**][**Ground-face**] finish. [**Match Architect's samples**].
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

L. Concrete Masonry Unit Admixtures:

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, will show no visible water or leaks on the back of test specimen.

a. Location: [**For exposed units**][**and**][**where indicated on Drawings**] .

2.5 CLAY MASONRY UNITS

A. Regional Materials: Verify brick is manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Regional Materials: Verify brick is manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications [**where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels**][**requiring brick of size, form, color, and texture on exposed surfaces that cannot be**

produced by sawing][**where shapes produced by sawing would result in sawed surfaces being exposed to view**] .

D. Hollow Clay Facing Brick: ASTM C652, Grade [**SW**][**MW**] , Type [**HBA**][**HBB**][**HBX**][**HBS**] , Class [**H40V**][**H60V**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Echelon Masonry, an Oldcastle APG brand**]
   e. [**Endicott Clay Products Co**]
   f. [**General Shale, Inc.**]
   g. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**as directed by the Owner**] .

E. Solid Clay Facing Brick: ASTM C216, Grade [**SW**][**MW**] , Type [**FBX**][**FBS**][**FBA**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Boral Bricks, Inc; Boral Limited**]
   e. [**Echelon Masonry, an Oldcastle APG brand**]
   f. [**Endicott Clay Products Co**]
   g. [**General Shale, Inc.**]
   h. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**as directed by the Owner**] .

F. Solid Building Brick: ASTM C62, Grade [**SW**][**MW**][**NW**] .

1. Size (Actual Dimensions): [**3-1/2 inches (89 mm) wide by 2-1/4 inches (57 mm) high by 7-1/2 inches (190 mm) long**][**or**][**3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long**] .
2. Application: Use for concealed brick unless otherwise indicated.

G. Glazed Brick: ASTM C1405, Grade [**S**][**SS**] , Class [**Exterior**][**Interior**] , Division [**Solid**][**H40V**][**H60V**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Belden Brick Company (The)**]
    b. [**Elgin Butler Company**]
    c. [**Glen-Gery Corporation**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**][**7-5/8 inches (194 mm)**] high by [**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**11-5/8 inches (295 mm)**] long.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and provide Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Application: Use where [**brick is exposed unless otherwise**] indicated.
5. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**] .
6. [**Where indicated to "match existing,"**] provide glazed brick matching color range, texture, and size of existing adjacent brickwork.

2.6 STRUCTURAL CLAY FACING TILE

A. General: Provide solid, multicored, or hollow units, with shape and direction of cores optional unless

otherwise indicated.

1. Where reinforced masonry is indicated, provide multicored units designed for use in reinforced, grouted masonry, either with vertical cores and with webs notched to receive horizontal reinforcement, or with horizontal cores and with holes in bed shells for placement of grout and to receive vertical reinforcement.
2. Where indicated for exterior applications, provide units recommended by manufacturer for exterior use in Project's location.
3. Provide special shapes where required for corners, jambs, coved bases, sills, and other special conditions indicated, including applications that cannot be produced by sawing standard units.

    a. Provide [**bullnose**][**square-edged**] units for outside corners unless otherwise indicated.
    b. Provide coved internal corners.
    c. Provide recessed, coved base units.

4. Where direct application of plaster is indicated or where bonded to backup masonry, provide units with rough, combed, or scored faces.

B. Glazed Structural Clay Facing Tile: ASTM C126, Grade [**S**][**SS**] .

1. Sizes: [**6P Series with actual face dimensions of 3-5/8 inches (92 mm) high by 11-5/8 inches (295 mm)**][**6T Series with actual face dimensions of 5 inches (127 mm) high by 11-11/16 inches (297 mm)**][**4W Series (8-Square) with actual face dimensions of 7-5/8 inches (194 mm) high by 7-5/8 inches (194 mm)**][**4S Series with actual face dimensions of 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm)**][**8W Series with actual face dimensions of 7-5/8 inches (194 mm) high by 15-5/8 inches (397 mm)**] long by widths indicated.
2. Width: Manufactured to dimensions [**5/16 inch (8 mm)**][**3/8 inch (10 mm)**] less than nominal dimensions.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Provide special units glazed on ends and tops, as well as faces for corners, jambs, sills, pilasters, columns, and other applications indicated, where glazed units are exposed on other surfaces and faces.
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**].
6. [**Where shown to "match existing,"**] provide glazed structural clay facing tile matching color range, texture, and size of existing adjacent glazed structural clay facing tile.

C. Unglazed Structural Clay Facing Tile: ASTM C212, Type [**FTX**][**FTS**] , Class [**Standard**][**Special-Duty**] .

1. Number of Faces: Single faced [**where only one finished face is exposed when units are installed; double faced, where both finished faces are exposed when units are installed**] .
2. Size: [**As indicated**][**Match existing**] .

2.7 FIREPLACE AND CHIMNEY LINING UNITS

A. Firebox Brick: ASTM C1261, size required to produce lining thickness indicated.

B. Clay Flue Lining Units: ASTM C315.

2.8 LINTELS

A. Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density

classification; and with reinforcing bars indicated. [**Provide lintels with net-area compressive strength of not less than that of CMUs.**][**Provide lintels with net-area compressive strength as indicated.**]

B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete" and with reinforcing bars indicated.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

D. Offset Angle Supports: Steel plate brackets anchored to structure, allowing continuous insulation behind shelf angle supporting veneer. Component and anchor size and spacing engineered by manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**FERO Corporation**]
b. [**Halfen USA, Inc.**]
c. [**Hohmann & Barnard, Inc**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] .
3. Carbon Steel: ASTM A1008/A1008M [**with ASTM A153/A153M, Class B coating**] .

2.9 MORTAR AND GROUT MATERIALS

A. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide mortar and grout materials to achieve performance requirements as specified in mortar and grout mixes.

D. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

E. Hydrated Lime: ASTM C207, Type S.

F. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

G. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Argos USA LLC**]
b. [**Cemex S.A.B. de C.V.**]
c. [**Fairborn Cement Company**]
d. [**Federal White Cement, Ltd.**]
e. [**Heidelberg Materials**]
f. [**Holcim (US) Inc**]
g. [**Lafarge North America Inc.**]
h. [**Lehigh White Cement Company**]
i. [**Quikrete; The QUIKRETE Companies, LLC**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]

H. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Lafarge North America Inc.**]

I. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Davis Colors**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Lanxess Corporation**]
d. [**Solomon Colors Inc.**]

J. Colored Mortar: Packaged blend made from [**portland cement-lime mix**][**or**][**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Heidelberg Materials**]

3) [**Holcim (US) Inc**]
4) [**Lafarge North America Inc.**]

2. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Cemex S.A.B. de C.V.**]
3) [**Fairborn Cement Company**]
4) [**Heidelberg Materials**]
5) [**Holcim (US) Inc**]
6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.

K. Preblended Dry Mortar Mix: Packaged blend complying with ASTM C1714/C1714M.

1. Preblended Dry Portland Cement Mortar Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**Quikrete; The QUIKRETE Companies, LLC**]
3) [**Sakrete; CRH Americas, Oldcastle APG**]
4) [**SPEC MIX, LLC**]

b. Dry Mortar Mix Materials: Made from [**portland cement-lime mix**][**masonry cement**][**or**][**mortar cement**] , sand, [**mortar pigments,**][**water repellent admixture**] .

2. Preblended Dry Masonry Cement Mortar Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**SPEC MIX, LLC**]

L. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6.4 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

M. Aggregate for Grout: ASTM C404.

N. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or prefaced masonry units (and approved for use by manufacturer of units); in color indicated or, if not otherwise indicated, as directed by the Owner.

O. Refractory Mortar Mix: Ground fireclay or nonwater-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C199 test; or an equivalent product acceptable to authorities having jurisdiction.

P. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with [**ASTM C494/C494M, Type C**][**ASTM C1384**] , and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**GCP Applied Technologies Inc.**]

Q. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACM Chemistries**]
   b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   c. [**GCP Applied Technologies Inc.**]
   d. [**Master Builders Solutions**]

R. Water: Potable.

2.10 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60 (Grade 420)**.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold or lock more securely reinforcing bars in center of cells. Units are formed from minimum **0.148-inch (3.77-mm)** diameter steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Heckmann Building Products, Inc.**]
    c. [**Hohmann & Barnard, Inc**]
    d. [**Wire-Bond**]

C. Masonry-Joint Reinforcement: ASTM A951/A951M.

1. Interior Walls: [**Mill-**][**Hot-dip**] galvanized carbon steel.
2. Exterior Walls: [**Hot-dip galvanized carbon**][**Stainless**] steel.
3. Wire Size for Side Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
4. Wire Size for Cross Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
5. Wire Size for Veneer Ties: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than **16 inches (406 mm)** o.c.
7. Provide in lengths of not less than **10 ft. (3 m)**[**with prefabricated corner and tee units**] .

D. Masonry-Joint Reinforcement for Single-Wythe Masonry:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Hohmann & Barnard, Inc**]
    c. [**Wire-Bond**]

2. Type: Ladder [**or truss**] with single pair of side rods.

E. Masonry-Joint Reinforcement for Multiwythe Masonry:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Heckmann Building Products, Inc.**]
    c. [**Hohmann & Barnard, Inc**]
    d. [**Wire-Bond**]

2. Ladder type with one side rod at each face shell of hollow masonry units more than **4 inches (102 mm)** wide, plus [**one side rod**][**two side rods**] at each wythe of masonry **4 inches (102 mm)** wide or less.
3. Tab type, either ladder or truss design, with one side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least **5/8-inch (16-mm)** cover on outside face.
4. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of

backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of **1/16 inch (1.6 mm)** and maximum vertical adjustment of **1-1/4 inches (32 mm)**. Size ties to extend at least halfway through facing wythe but with at least **5/8-inch (16-mm)** cover on outside face. [**Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.**]

F. Masonry-Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single **0.187-inch- (4.76-mm-)** diameter, [**hot-dip galvanized carbon**][**stainless**] steel continuous wire.

2.11 TIES AND ANCHORS

A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into veneer but with at least a **5/8-inch (16-mm)** cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, [**Type 304**][**Type 316**] .
4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] .
7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
8. Stainless Steel Bars: ASTM A276 or ASTM A666/A666M, Type 304.

C. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 13 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.0336-inch- (0.85-mm-) thick steel sheet, galvanized after fabrication**][**0.0635-inch- (1.61-mm-) thick steel sheet, galvanized after fabrication**][**0.0312-inch- (0.79-mm-) thick, stainless steel sheet**][**0.0625-inch- (1.59 mm-) thick, stainless steel sheet**] .

D. Individual Wire Ties: Rectangular units with closed ends and not less than **4 inches (100 mm)** wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than **2 inches (51 mm)** long for masonry constructed from solid units.
2. Where wythes [**do not align**][**are of different materials**] , use adjustable ties with pintle-and-eye connections having a maximum adjustment of **1-1/4 inches (32 mm)**.
3. Wire: Fabricate from [**3/16-inch- (4.76-mm-)**][**1/4-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.**]

E. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3GEN Masonry Products, Inc.**]

2. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
3. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]

F. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: [**Dovetail**][**Channel**] tabs for inserting into [**dovetail**][**channel**] slots in concrete and attached to tie section; formed from [**0.060-inch- (1.52-mm-) thick steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] .

    a. [**0.064-inch- (1.63-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized-steel sheet may be used at interior walls unless otherwise indicated.

2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
3. Corrugated-Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 13 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from [**0.0635-inch- (1.61-mm-) thick steel sheet, galvanized after fabrication**][**0.0785-inch- (1.99 mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0625-inch- (1.59-mm-) thick, stainless steel sheet**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] with [**dovetail**][**channel**] tabs for inserting into slots in concrete.

    a. [**0.064-inch- (1.63-mm-)**][**0.079-inch- (2.01-mm-)**][**0.108-inch- (2.74-mm-)**] thick galvanized sheet may be used at interior walls unless otherwise indicated.

G. Partition Top Anchors: **0.105-inch- (2.66-mm-)** thick metal plate with a **3/8-inch- (10-mm-)** diameter metal rod **6 inches (152 mm)** long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from [**steel, hot-dip galvanized after fabrication**][**stainless steel**] .

H. Rigid Anchors: Fabricate from steel bars [**1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated**][**bent to configuration indicated**] .

1. Corrosion Protection: [**Hot-dip galvanized to comply with ASTM A153/A153M**][**Epoxy coating 0.020 inch (0.51 mm) thick**][**Rust-inhibitive paint**] .

I. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a **100 lbf (445 N)** load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of **1/16 inch (1.6 mm)**.
2. Fabricate sheet metal anchor sections and other sheet metal parts from [**0.0785-inch- (1.99-mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] .

3. Fabricate wire ties from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized-steel**][**stainless steel**] wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie with seismic accessories [**and washer at face of insulation**] .

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**3GEN Masonry Products, Inc.**]
        2) [**FERO Corporation**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**PROSOCO, Inc**]
        5) [**Wire-Bond**]

6. Masonry-Veneer Anchors; Double-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting horizontal leg with slots for vertical legs of double pintle wire tie.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Heckmann Building Products, Inc.**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**Quality Steel and Wire LLC**]
        5) [**Wire-Bond**]

    b. Seismic: Provide seismic tie, clip, and continuous wire in veneer.

7. Masonry-Veneer Anchors; Slotted Plate: Sheet metal anchor section, with screw holes at top and bottom; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Heckmann Building Products, Inc.**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**Quality Steel and Wire LLC**]
        5) [**Wire-Bond**]

8. Masonry-Veneer Anchors; Slotted Plate with Prongs: Sheet metal anchor section, with screw holes at top and bottom; top and bottom ends bent to form pronged legs of length to match

thickness of insulation; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

9. Masonry-Veneer Anchors; Single-Barrel Screw: Self-drilling, single-barrel screw designed to receive wire tie. Screw has a smooth barrel the same thickness as insulation.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**3GEN Masonry Products, Inc.**]
2) [**Heckmann Building Products, Inc.**]
3) [**Hohmann & Barnard, Inc**]
4) [**PROSOCO, Inc**]
5) [**TruFast; a brand of Altenloh, Brinck & Co. US, Inc.**]
6) [**Wire-Bond**]

b. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
c. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

10. Masonry-Veneer Anchors; Single-Barrel Screw with Double-Pintle Wingnut: Self-drilling, single-barrel screw with wingnut or clip designed to receive double-pintle wire tie. Screw has a smooth barrel the same thickness as insulation.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]

b. Fastener Configuration: Single-barrel screw with [**wingnut head**][**thermally resistant wingnut head**][**thermally resistant clip**] .
c. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
d. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

11. Masonry-Veneer Anchors; Seismic-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting leg with slotted hole for vertical leg of seismic pintle tie. Tie is rib-stiffened, sheet metal bent plate with down-turned leg to fit in anchor slot and with

integral tabs to hold continuous wire in veneer.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

12. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours in accordance with ASTM B117.
13. Stainless Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon-steel drill point and 300 Series stainless steel shank.

2.12 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3GEN Masonry Products, Inc.**]
b. [**Cheney Flashing Company**]
c. [**Hohmann & Barnard, Inc**]
d. [**Keystone Flashing Company, Inc**]
e. [**Wire-Bond**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
3. Copper: [**ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. (4.9 kg/sq. m) weight or 0.0216 inch (0.55 mm) thick**][**or**][**ASTM B370, Temper H01, high-yield copper sheet, 12 oz./sq. ft. (3.7 kg/sq. m) weight or 0.0162 inch (0.41 mm) thick**] .
4. Fabricate continuous flashings in sections **96 inches (2438 mm)** long minimum, but not exceeding **12 ft. (3.7 m)**. Provide splice plates at joints of formed, smooth metal flashing.
5. Fabricate through-wall metal flashing embedded in masonry from [**stainless steel**][**copper**] , with sawtooth ribs at **3-inch (76-mm)** intervals along length of flashing to provide an integral mortar bond.
6. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
7. Fabricate through-wall flashing with drip edge [**where**][**unless otherwise**] indicated. Fabricate by extending flashing **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
8. Fabricate through-wall flashing with sealant stop [**where**][**unless otherwise**] indicated. Fabricate by bending metal back on itself **3/4 inch (19 mm)** at exterior face of wall and down into joint **1/4 inch (6.4 mm)** to form a stop for retaining sealant backer rod.

9. Fabricate metal [**drip edges**][**and**][**sealant stops**] for sawtooth metal flashing from plain metal flashing of same metal as sawtooth flashing and extending at least **3 inches (76 mm)** into wall with hemmed inner edge to receive sawtooth flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
10. Fabricate metal drip edges from stainless steel. Extend at least **3 inches (76 mm)** into wall and **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
11. Fabricate metal sealant stops from stainless steel. Extend at least **3 inches (76 mm)** into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for **3/4 inch (19 mm)** and down into joint **1/4 inch (6.4 mm)** to form a stop for retaining sealant backer rod.
12. Fabricate metal expansion-joint strips from [**stainless steel**][**copper**] to shapes indicated.
13. Solder metal items at corners.

B. Flexible Flashing: Where flashing is fully concealed in masonry, use one of the following unless otherwise indicated:

1. Copper-Fabric Flashing: Copper sheet bonded between two layers of glass-fiber cloth.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Advanced Building Products Inc.**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**STS Coatings, Inc.**]
      4) [**Wire-Bond**]
      5) [**York Manufacturing, Inc**]

   b. Sheet Weight: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .
   c. Sheet Type: [**Non-adhesive**][**Self-adhesive**] .

2. Asphalt-Coated Copper Flashing: Copper sheet coated with flexible asphalt.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Hohmann & Barnard, Inc**]
      2) [**Wire-Bond**]

   b. Sheet Weight: [**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .

3. Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**3GEN Masonry Products, Inc.**]

2) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
3) [**Hohmann & Barnard, Inc**]
4) [**PROSOCO, Inc**]
5) [**STS Coatings, Inc.**]
6) [**Wire-Bond**]
7) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Overall Thickness: Manufacturer's standard.

4. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**3GEN Masonry Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**STS Coatings, Inc.**]
4) [**VaproShield LLC**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Bonding Agent: [**Butyl**][**Permanent, clear**] adhesive.
d. Overall Thickness: Manufacturer's standard.

5. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Carlisle Coatings & Waterproofing Inc**]
3) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
4) [**GCP Applied Technologies Inc.**]
5) [**Heckmann Building Products, Inc.**]
6) [**Hohmann & Barnard, Inc**]
7) [**Polyguard Products, Inc.**]
8) [**W. R. Meadows, Inc**]
9) [**Williams Products, Inc.**]
10) [**Wire-Bond**]
11) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**30 mils (0.76 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] .

6. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl

rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**DuPont de Nemours, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**Kingspan Insulation LLC**]
4) [**Protecto Wrap Company**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**35 mils (0.89 mm)**][**40 mils (1.0 mm)**] .

7. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**3GEN Masonry Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Hyload; IKO Industries, Inc.**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]

b. Monolithic Sheet: Elastomeric thermoplastic flashing, **40 mils (1.0 mm)** thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, **25 mils (0.64 mm)** thick, with a **15-mil- (0.38-mm-)** thick coating of adhesive.

1) Color: [**Gray**][**White**][**Tan/buff**][**Black**] .

8. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Carlisle Coatings & Waterproofing Inc**]
2) [**Elevate; Amrize Building Envelope LLC**]
3) [**Heckmann Building Products, Inc.**]
4) [**Hohmann & Barnard, Inc**]
5) [**Wire-Bond**]

b. Thickness: **40 mils (1.0 mm)**.

C. Drainage Plane Flashing: Provide flashing materials as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3GEN Masonry Products, Inc.**]
   b. [**Mortar Net Solutions**]
   c. [**STS Coatings, Inc.**]
   d. [**York Manufacturing, Inc**]

2. Fabrication: [**Stainless steel**][**Copper**][**Rubberized asphalt**][**Elastomeric membrane**] and drainage membrane to shapes indicated [**including weep tabs, termination bar, and drip edge**] .

   a. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
   b. Copper: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**] thick.
   c. Rubberized Asphalt: [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.
   d. Elastomeric Membrane: [**EPDM complying with ASTM D4637/D4637M**][**PVC**][**PVC with Elvaloy Kee**][**TPO**] , [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.

3. Fabricate continuous flashings in sections **60 inches (1524 mm)** long, minimum.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Mortar Net Solutions**]

E. Preformed Corners, End Dams, and Seaming Shapes for Flashing: Flashing manufacturer's standard products or products recommended by flashing manufacturer for waterproofing openings.

F. Solder and Sealants for Sheet Metal Flashings: [**As specified in Section 076200 "Sheet Metal Flashing and Trim."**]

1. Solder for Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
2. Solder for Copper: ASTM B32, [**Grade Sn50**][**with maximum lead content of 0.2 percent**] .
3. Elastomeric Sealant: ASTM C920, chemically curing [**urethane**][**polysulfide**][**silicone**] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

G. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

H. Termination Bars for Flexible Flashing:

1. Material: [**Aluminum**][**Stainless steel**][**Rigid PVC**]
2. Size: [**0.075 by 1 inch (1.90 by 25 mm)**][**1/8 by 1 inch (3.2 by 25 mm)**][**1/8 by 1-1/8 inch (3.2 by 29 mm)**] .

I. Termination Bars for Flexible Flashing, Flanged:

1. Material: [**Stainless steel sheet 0.019 by 1-1/2 inches (0.48 by 38 mm)**][**Aluminum sheet 0.064 by 1-1/2 inches (1.63 by 38 mm)**] .
2. Fabricate with a **3/8-inch (10-mm)** flange at top [**and bottom**] .

2.13 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [**neoprene**][**urethane**][**or**][**PVC**] .

B. Preformed Control-Joint Gaskets: Made from [**styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805**][**or**][**PVC, complying with ASTM D2287, Type PVC-65406**] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

D. Weep/Cavity Vents: Use one of the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton, **1/4 to 3/8 inch (6.4 to 10 mm)** in diameter, in length required to produce **2-inch (51-mm)** exposure on exterior and **18 inches (457 mm)** in cavity. Use only for weeps.
2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, **3/8-inch (10-mm)** OD by **4 inches (102 mm)** long.
3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, **3/8 by 1-1/2 by 3-1/2 inches (10 by 38 by 89 mm)** long.
4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe, in color selected from manufacturer's standard.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Advanced Building Products Inc.**]
        3) [**Heckmann Building Products, Inc.**]
        4) [**Hohmann & Barnard, Inc**]
        5) [**Mortar Net Solutions**]
        6) [**Wire-Bond**]

5. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe; in color selected from manufacturer's standard.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

1) [**CavClear; a division of Archovations, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]

6. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color, as directed by the Owner.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]** :

1) [**Hohmann & Barnard, Inc**]
2) [**Williams Products, Inc.**]
3) [**Wire-Bond**]

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Mortar Deflector:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]** :

1) [**Advanced Building Products Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Size: Strips [**full depth of cavity**][**3/4 inch (19 mm) thick**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] and [**10 inches (254 mm)**][**16 inches (406 mm)**] high.
c. Surface Drainage: [**Dovetail-shaped notches**][**Dimpled surface**] that prevents clogging with mortar droppings.

2. Rainscreen Drainage Mat:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]** :

1) [**Advanced Building Products Inc.**]
2) [**CavClear; a division of Archovations, Inc.**]

3) [**Keene Building Products**]
4) [**Maxxon Corporation**]
5) [**Mortar Net Solutions**]
6) [**Wire-Bond**]

b. Size: Sheets or strips not less than [**full depth of cavity**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] thick and installed to full height of cavity.
c. Surface Drainage: Provide additional strips **4 inches (102 mm)** high at weep holes and thick enough to fill entire depth of cavity to prevent weep holes from clogging with mortar.

F. Masonry Cell Fill: [**Loose-Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation)**][**Lightweight-Aggregate Fill: ASTM C331/C331M**][**Foamed-in-place masonry cell fill**] .

G. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**EaCo Chem, Inc.**]
c. [**PROSOCO, Inc**]

2.14 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar unless otherwise indicated.
3. For exterior masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
4. For reinforced masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, [**Proportion**][**Property**] Specification. Provide the following types of mortar for applications stated unless another type is indicated [**or needed to provide required compressive strength of masonry**] .

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use [**Type M**][**Type S**][**Type N**] .
3. For mortar parge coats, use [**Type S**][**or**][**Type N**] .
4. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior nonload-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product [**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored mortar cement**] .

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.
3. Mix to match Architect's sample.
4. Application: Use pigmented mortar for exposed mortar joints, as directed by the Owner.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints, as directed by the Owner.

F. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 402/602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, [**Table 1**][**or**][**paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa)**] .
3. Provide grout with a slump of [**8 to 11 inches (203 to 279 mm)**][**10 to 11 inches (254 to 279 mm)**] as measured in accordance with ASTM C143/C143M.

G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

1. Application: Use epoxy pointing mortar for exposed mortar joints, as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (13 mm)** or minus **1/4 inch (6.4 mm)**.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (13 mm)**.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6.4 mm)** in a story height or **1/2 inch (13 mm)** total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.6 mm)** except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**, with a maximum thickness limited to **1/2 inch (13 mm)**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3.2 mm)**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (10 mm)** or minus **1/4 inch (6.4 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**. [**Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3.2 mm).**]
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than **1/16 inch (1.6 mm)** from one masonry unit to the next.

3.4 INSTALLATION OF MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [**running bond**][**stack bond**][**one-third running bond**][**Flemish bond**][**English bond**][**bond pattern indicated on Drawings**] ; do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] . Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-In Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout **24 inches (610 mm)** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Rigid, Cellular Thermal Insulation, CMUs: Install molded-polystyrene insulation units into masonry unit cells before laying units.

J. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of hollow CMUs solidly around plastic tubes of anchors, and push tubes down into grout to provide **1/2-inch (13-mm)** clearance between end of anchor rod and end of tube. Space anchors [**48 inches (1219 mm)**] o.c. unless otherwise indicated.

3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 INSTALLATION OF MORTAR BEDDING AND JOINTING

A. General: Lay masonry units as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Hollow Clay Facing Brick: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Solid Masonry Units: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

D. Structural Clay Facing Tiles: Lay units as follows:

1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with **1/4- to 3/8-inch- (6.4- to 10-mm-)** thick joints.

E. Firebox Brick: Set units in full bed of refractory mortar with full head joints. Form joints by buttering both surfaces of adjoining brick and sliding it into place. Make joints just wide enough to accommodate variations in size of brick, approximately **1/8 inch (3.2 mm)**. Tool joints smooth on surfaces exposed to fire or smoke.

F. Clay Flue Lining Units: Install units to comply with ASTM C1283. Install flue liners ahead of surrounding masonry. Set clay flue liners in full bed of refractory mortar **1/16 to 1/8 inch (1.6 to 3.2 mm)** thick. Strike joints flush on inside of flue to provide smooth surface. Maintain expansion space between flue liner and surrounding masonry except where surrounding masonry is required to provide lateral support for flue liners.

G. Trim Units: Set [**stone**][**cast-stone**] trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.
4. Rake out mortar joints for pointing with sealant.

H. Rake out mortar joints at [**prefaced CMUs**][**glazed brick**][**and**][**glazed structural clay facing tile**] to a

uniform depth of **1/4 inch (6.4 mm)** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

I. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer **3/4 inch (19 mm)** or more in width.

J. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

K. Cut joints flush where indicated to receive [**waterproofing**][**cavity wall insulation**][**air barriers**] unless otherwise indicated.

3.6 INSTALLATION OF COMPOSITE MASONRY

A. Bond wythes of composite masonry together [**using one of the following methods**][**as follows**] :

1. Individual Wire Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for [**4.5 sq. ft. (0.42 sq. m)**][**2.67 sq. ft. (0.25 sq. m)**][**1.77 sq. ft. (0.16 sq. m)**] of wall area spaced not to exceed [**36 inches (914 mm)**][**24 inches (610 mm)**][**16 inches (406 mm)**] o.c. horizontally and **16 inches (406 mm)** o.c. vertically. Stagger ties in alternate courses. Provide additional ties within **12 inches (305 mm)** of openings and space not more than **36 inches (914 mm)** apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than **24 inches (610 mm)** o.c. vertically.

a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.

2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

a. Where bed joints of both wythes align, use [**ladder-type reinforcement extending across both wythes**][**tab-type reinforcement**] .
b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] .

3. Header Bonding: Provide masonry unit headers extending not less than **3 inches (76 mm)** into each wythe. Space headers not more than [**8 inches (200 mm)**][**12 inches (300 mm)**] clear horizontally and **16 inches (400 mm)** clear vertically.

B. Bond wythes of composite masonry together using bonding system indicated on Drawings.

C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.

1. Structural Clay Facing Tile: After each course is laid, fill the vertical, longitudinal joint between wythes solidly with mortar at [**exterior walls, except cavity walls**][**and**][**interior walls and partitions**] .

D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.

1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.

E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are indicated at juncture, bond walls together as follows:

1. Provide individual wire ties not more than [8 inches (203 mm)][16 inches (406 mm)] o.c.
2. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.
3. Provide rigid metal anchors not more than [24 inches (610 mm)][48 inches (1219 mm)] o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 INSTALLATION OF CAVITY WALLS

A. Bond wythes of cavity walls together as follows:

1. Individual Wire Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for [4.5 sq. ft. (0.42 sq. m)][2.67 sq. ft. (0.25 sq. m)][1.77 sq. ft. (0.16 sq. m)] of wall area spaced not to exceed [36 inches (914 mm)][24 inches (610 mm)][16 inches (406 mm)] o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (914 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.

   a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.
   b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) ties to allow for differential movement regardless of whether bed joints align.

2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

   a. Where bed joints of both wythes align, use [**ladder-type reinforcement extending across both wythes**][**tab-type reinforcement**] .
   b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] .
   c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] to allow for differential movement regardless of whether bed joints align.

3. Header Bonding: Provide masonry unit headers extending not less than 3 inches (76 mm) into each wythe. Space headers not more than [8 inches (203 mm)][12 inches (305 mm)] clear horizontally and 16 inches (406 mm) clear vertically.
4. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Bond wythes of cavity walls together using bonding system indicated on Drawings.

C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

D. Parge cavity face of backup wythe in a single coat approximately 3/8 inch (10 mm) thick. Trowel face of parge coat smooth.

E. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (305 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as indicated.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.8 INSTALLATION OF ANCHORED MASONRY VENEERS

A. Masonry-veneer anchors to comply with the following requirements:

1. Fasten [**screw-attached**][**and**][**seismic**] anchors [**through sheathing to wall framing**][**and**][**to concrete and masonry backup**] with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed [**tie sections**][**connector sections and continuous wire**] in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and **24 inches (610 mm)** o.c. horizontally, with not less than one anchor for each **2 sq. ft. (0.2 sq. m)** of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **8 inches (203 mm)**, around perimeter.
5. Space anchors as indicated, but not more than **16 inches (406 mm)** o.c. vertically and **25 inches (635 mm)** o.c. horizontally, with not less than one anchor for each [**2.67 sq. ft. (0.25 sq. m)**][**3.5 sq. ft. (0.33 sq. m)**] of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **36 inches (914 mm)**, around perimeter.
6. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and horizontally. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **24 inches (610 mm)**, around perimeter.

B. Provide not less than [**2 inches (51 mm)**][**1 inch (25 mm)**] of airspace between back of masonry veneer and face of [**sheathing**][**insulation**] .

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.9 INSTALLATION OF MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of **5/8 inch (16 mm)** on exterior side of walls, **1/2 inch (13 mm)** elsewhere. Lap reinforcement a minimum of **6 inches (152 mm)**.

1. Space reinforcement not more than **16 inches (406 mm)** o.c.
2. Space reinforcement not more than **8 inches (203 mm)** o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than **8 inches (203 mm)** above and below wall openings and extending **12 inches (305 mm)** beyond openings [**in addition to continuous reinforcement**] .

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at [**corners,**] returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 INSTALLATION OF ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than [1/2 inch (13 mm)][1 inch (25 mm)][2 inches (51 mm)] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (914 mm) o.c. horizontally.

3.11 INSTALLATION OF CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Indicate locations of joints on Drawings. Form control joints in concrete masonry as follows:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches (102 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than [3/8 inch (10 mm)][1/2 inch (13 mm)] for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than [3/8 inch (10 mm)] .

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.12 INSTALLATION OF LINTELS

A. Provide lintel types where indicated on Drawings and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are indicated without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches (203 mm) at each jamb unless otherwise indicated.

3.13 INSTALLATION OF EMBEDDED FLASHING

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. [**Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.**]

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape [**as recommended by flashing manufacturer**] .
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of [**4 inches (102 mm)**][**8 inches (203 mm)**] , and through inner wythe to within **1/2 inch (13 mm)** of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately **2 inches (51 mm)** on interior face.
3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of [**4 inches (102 mm)**][**8 inches (203 mm)**] , and **1-1/2 inches (38 mm)** into the inner wythe. [**Form 1/4-inch (6.4-mm) hook in edge of flashing embedded in inner wythe.**]
4. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least **8 inches (203 mm)**; with upper edge tucked under [**water-resistive barrier**][**air barrier**] , lapping at least **4 inches (102 mm)**. [**Fasten upper edge of flexible flashing to sheathing through termination bar.**]
5. At lintels and shelf angles, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] at each end. At heads and sills, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] and turn ends up not less than **2 inches (51 mm)** to form end dams.
6. Interlock end joints of sawtooth sheet metal flashing by overlapping ribs not less than **1-1/2 inches (38 mm)** or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
7. Install metal [**drip edges**][**and**][**sealant stops**] with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
8. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
9. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
10. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Single-Wythe CMU Flashing System: Install in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.

3.14 INSTALLATION OF WEEP/CAVITY VENTS

A. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use [**specified weep/cavity vents**][**or**][**open-head joints**] to form weep holes.

2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes **24 inches (610 mm)** o.c. unless otherwise indicated.
4. Space weep holes formed from [**plastic tubing**][**or**][**wicking material**] **16 inches (406 mm)** o.c.
5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Trim wicking material flush with outside face of wall after mortar has set.

B. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than **2 inches (51 mm)**, to maintain drainage.

1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than **24 inches (610 mm)** above top of pea gravel.

C. Cavity Drainage Material: Place in [**cavities**][**airspace behind veneers**] to comply with configuration requirements for cavity drainage material in "Accessories" Article.

D. Install cavity vents in head joints in exterior wythes at spacing indicated. Use [**specified weep/cavity vent**][**or**][**open-head joints**] to form cavity vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.15 INSTALLATION OF REIINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 402/602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than [**60 inches (1524 mm)**][**12.67 ft. (3.86 m)**] .

3.16 INSTALLATION OF MASONRY CELL FILL

A. Loose-Fill Insulation: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft. (6 m)**.

B. Lightweight-Aggregate Fill: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft. (6 m)**.

C. Foamed-in-Place Masonry Cell Fill: Drill holes in mortar bed joints at spacing as indicated in writing by foamed-in-place masonry fill manufacturer, and inject foam to fill masonry cell voids.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Inspections: Special inspections in accordance with [**Level 2**][**Level 3**] in TMS 402/602.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each **5000 sq. ft. (464 sq. m)** of wall area or portion thereof.

E. Concrete Masonry Units: Test each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Clay Masonry Units: Test each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

G. Mortar Aggregates: Ratio test (Proportion Specification) for each mix provided, in accordance with ASTM C780.

H. Mortar: Test each mix provided in accordance with ASTM C780. Test mortar for [**mortar air content**][**and**][**compressive strength**] .

I. Grout: Test each mix provided in accordance with ASTM C1019.

J. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at [**7 days and at**] 28 days.

3.18 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of **3/4 inch (19 mm)**. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of **1/8 inch per foot (3.2 mm per 305 mm)**. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.19 REPAIRING AND POINTING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

3.20 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry, as directed by the Owner.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in TEK 08-04A.
7. Clean masonry with a proprietary acidic masonry cleaner applied in accordance with manufacturer's written instructions.

3.21 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than **4 inches (102 mm)** in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within **18 inches (457 mm)** of finished grade.

C. Masonry Waste Recycling: Return broken masonry units not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 20 00 00

SECTION 04 20 00 00A - MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clay masonry units.
2. Concrete masonry units.
3. Mortar materials.
4. Ties and anchors.
5. Embedded flashing.
6. Accessories.
7. Mortar mixes.

B. Products Installed, but Not Furnished, under This Section:

1. Cast-stone trim in masonry veneer.
2. Stone trim units in masonry veneer.
3. Steel lintels in masonry veneer.
4. Steel shelf angles for supporting masonry veneer.

C. Related Requirements:

1. Section 019119.43 "Exterior Enclosure Commissioning."
2. Section 033000 "Cast-in-Place Concrete" for [**installing**] dovetail slots or channel slots for masonry-veneer anchors.
3. Section 034100 "Precast Structural Concrete" for thin brick veneer.
4. Section 034500 "Precast Architectural Concrete" for thin brick veneer.
5. Section 042000 "Unit Masonry" for multi-wythe masonry veneer assemblies.
6. Section 042200 "Concrete Unit Masonry" for full-size, single-wythe CMU assemblies.
7. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
8. Section 044313.13 "Anchored Stone Masonry Veneer" for thin stone trim set as anchored veneer.
9. Section 044313.16 "Adhered Stone Masonry Veneer" for thin stone trim set as adhered veneer.
10. Section 047200 "Cast Stone Masonry" for cast-stone trim units.
11. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural-steel frame.
12. Section 071900 "Water Repellents" for water repellents applied to masonry veneer assemblies.
13. Section 072500 "Weather Barriers" for weather barriers part of masonry veneer assemblies.
14. Section 076200 "Sheet Metal Flashing and Trim" for [**exposed**] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
15. Section 092900 "Gypsum Board" for exterior backer board part of masonry veneer assemblies.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Exposed: Weather-exposed side of a constructed wall.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: For the following:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Thin Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Thin CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
8. Colored Mortar: Full range of manufacturer's standard colors.
9. Aggregate for Mortar: Range of aggregate colors for colored-aggregate mortar.
10. Weep/cavity vents.

D. Samples for Verification: For each type and color of the following:

1. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Thin Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Thin CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
8. Special Masonry Shapes: One of each unique shape.
9. Colored Mortar: Full range of manufacturer's standard colors.
10. Pigmented Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
11. Colored-Aggregate Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
12. Weep/cavity vents.
13. Cavity drainage material.
14. Accessories embedded in masonry.

E. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

1.5 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and include source of aggregates.

1. Submittal is for information only.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include [**data on material properties**][**material test reports substantiating compliance with requirements**] .
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M [**or a list of addresses of buildings in Project's area where proposed brick has been used successfully and with a history of durability**] .

2. Integral water repellent used in decorative CMUs.
3. Cementitious Materials: Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, Dry Mortar Mixes: Include description of type and proportions of ingredients.
6. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.

D. Qualification Statements: For testing agency.

E. Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements for [**cold**][**and**][**hot**] weather.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 MOCKUPS

A. Sample Panel Mockups: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for [**each type of exposed masonry veneer construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**] high [**by full thickness**] .
2. Build sample panels facing south.
3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of panels with masonry cleaner indicated.
5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing, as directed by the Owner.

B. Wall Mockups: Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**and**][**to set quality standards for installation**] .

1. Build mockup [**as indicated on Drawings**] .
2. Build mockups for [**each type of exposed masonry veneer construction**][**typical exterior wall**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**] high by full thickness, including face and backup wythes and accessories.

    a. Include a sealant-filled joint at least **16 inches (406 mm)** long in [**each**] mockup.
    b. Include lower corner of window opening [**framed with stone trim,**] at upper corner of exterior wall mockup. Make opening approximately **12 inches (305 mm)** wide by **16 inches (406 mm)** high.
    c. Include through-wall flashing installed for a **24-inch (610-mm)** length in corner of exterior wall mockup approximately **16 inches (406 mm)** down from top of mockup, with a **12-inch (305-mm)** length of flashing left exposed to view (omit masonry above half of flashing).
    d. Include wall substrate and cavity materials, veneer anchors, flashing [**cavity drainage material**] , and weep holes in exterior masonry-veneer wall mockup.

3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of mockups with masonry cleaner as indicated.
5. Protect accepted mockups from the elements with weather-resistant membrane.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If the units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of veneer, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of **24 inches (610 mm)** down face of veneer, and hold cover securely in place.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry. Immediately remove grout, mortar, and soil that come in contact with masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace masonry veneer damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**exposed masonry units**][**cementitious mortar components**][**and**][**mortar aggregate**] from single [**source**][**producer**][**or**][**manufacturer**] .

B. For [**exposed masonry units**][**and**][**cementitious mortar components**] , obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MASONRY VENEER, GENERAL

A. Masonry Standard: Comply with TMS 402/602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects will be exposed in the completed Work [**and will be within 20 ft. (6 m) vertically and horizontally of a walking surface**] .

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction.

2.3 CLAY MASONRY UNITS

A. Regional Materials: Verify brick is manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Regional Materials: Verify brick is manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications [**where stretcher units cannot accommodate special conditions, including corners, movement joints, bond beams, sashes, and lintels**][**requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing**][**where shapes produced by sawing would result in sawed surfaces being exposed to view**] .

D. Hollow Clay Facing Brick: ASTM C652, Grade [**SW**][**MW**] , Type [**HBX**][**HBS**][**HBA**] , Class H40V.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Brick Company**]
b. [**Belden Brick Company (The)**]
c. [**Bilco Brick Company**]
d. [**Echelon Masonry, an Oldcastle APG brand**]
e. [**Endicott Clay Products Co**]
f. [**General Shale, Inc.**]
g. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**As selected by Architect**] .

E. Solid Clay Facing Brick: ASTM C216, Grade [**SW**][**MW**] , Type [**FBX**][**FBS**][**FBA**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Acme Brick Company**]
    b. [**Belden Brick Company (The)**]
    c. [**Bilco Brick Company**]
    d. [**Boral Bricks, Inc; Boral Limited**]
    e. [**Echelon Masonry, an Oldcastle APG brand**]
    f. [**Endicott Clay Products Co**]
    g. [**General Shale, Inc.**]
    h. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**As selected by Architect**] .

9. Solid Building Brick: ASTM C62, Grade [**SW**][**MW**][**NW**] .

F. Glazed Brick: ASTM C126, Grade [**S**][**SS**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Belden Brick Company (The)**]
   b. [**Elgin Butler Company**]
   c. [**Glen-Gery Corporation**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**][**7-5/8 inches (194 mm)**] high by [**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**11-5/8 inches (295 mm)**] long.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Application: Use where [**brick is exposed unless otherwise indicated**][**indicated**] .
5. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
6. [**Where indicated to "match existing,"**] provide glazed brick matching color range, texture, and size of existing adjacent brickwork.

G. Thin Brick: ASTM C1088, Grade [**Exterior**][**Interior**] , Type [**TBA**][**TBS**][**TBX**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Elgin Butler Company**]
   c. [**General Shale, Inc.**]
   d. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Thin brick with colors or textures applied as coatings to withstand 50 cycles of freezing and thawing; ASTM C67/C67M, with no observable difference in applied finish when viewed from **10 ft. (3 m)**.
5. Size (Actual Dimensions): [**3/8 inches (10 mm)**][**1/2 inches (13 mm)**][**9/16 inches (14 mm)**][**5/8 inches (16 mm)**][**3/4 inches (19 mm)**][**1 inches (25 mm)**][**1-5/8 inches (41 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-3/16 inches (71 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**8-1/2 inches (216 mm)**][**9-1/2 inches (241 mm)**][**9-5/8 inches (244 mm)**][**11-5/8 inches (295 mm)**][**15-5/8 inches (397 mm)**][**19-1/4 inches (489 mm)**] long.
6. Installation Method: [**Thinset**][**Thickset**][**Modular panels systems**] .
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.

8. Color and Texture: [**Match Architect's samples**][**As selected by Architect**] .

2.4 CONCRETE MASONRY UNITS

A. Regional Materials: Verify CMUs are manufactured within **100 miles (160 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify CMUs are manufactured within **500 miles (800 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

D. Architectural CMUs: ASTM C90. [**normal weight**][**medium weight**][**lightweight**] architectural veneer units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Angelus Block Co., Inc.**]
   b. [**Echelon Masonry, an Oldcastle APG brand**]
   c. [**York Building Products**]

2. Size (Actual Dimensions): [**3-5/8 inches (92 mm) wide by 3-5/8 inches (92 mm) high by 15-5/8 inches (397 mm) long**] .
3. Pattern and Texture: [**Standard pattern, ground-face finish**][**Standard pattern, split-face finish**][**Standard pattern, split-ribbed finish**][**Scored vertically to appear square in stacked bond, standard finish**][**Triple scored vertically to appear as soldier courses in stacked bond, standard finish**][**Match Architect's samples**] .
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

E. Thin CMUs: ASTM C1877 and TMS 402/602 Ch. 13.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Angelus Block Co., Inc.**]

2. Size (Actual Dimensions): **1-5/8 inches (41 mm)** wide by [**3-5/8 inches (92 mm)**][**7-5/8 inches (193 mm)**] high by [**15-5/8 inches (397 mm) long**].

3. Pattern and Texture: [**Standard pattern, smooth finish**][**Match Architect's samples**] .
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

F. Concrete Facing Brick: ASTM C1634, [**normal weight**][**medium weight**][**lightweight**] solid units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Acme Brick Company**]
    b. [**Belden Brick Company (The)**]
    c. [**Bilco Brick Company**]
    d. [**Echelon Masonry, an Oldcastle APG brand**]
    e. [**Westbrook Concrete Block Co., Inc.**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**] high by [**7-5/8 inches (194 mm)**][**11-5/8 inches (295 mm)**][**15-5/8 inches (397 mm)**] long.
3. Texture: [**Smooth-face**][**Split-face**][**Ground-face**] finish. [**Match Architect's samples.**]
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

G. Concrete Masonry Unit Admixtures:

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, will show no visible water or leaks on the back of test specimen.

    a. Location: [**For exposed units**][**and**][**where indicated on Drawings**] .

2.5 MORTAR MATERIALS

A. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

D. Hydrated Lime: ASTM C207, Type S.

E. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

F. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Argos USA LLC**]
b. [**Cemex S.A.B. de C.V.**]
c. [**Fairborn Cement Company**]
d. [**Federal White Cement, Ltd.**]
e. [**Heidelberg Materials**]
f. [**Holcim (US) Inc**]
g. [**Lafarge North America Inc.**]
h. [**Lehigh White Cement Company**]
i. [**Quikrete; The QUIKRETE Companies, LLC**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]

G. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Lafarge North America Inc.**]

H. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Davis Colors**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Lanxess Corporation**]
d. [**Solomon Colors Inc.**]

I. Colored Mortar: Packaged blend made from [**portland cement-lime mix**][**or**][**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

1) [**Argos USA LLC**]
2) [**Heidelberg Materials**]
3) [**Holcim (US) Inc**]
4) [**Lafarge North America Inc.**]

2. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Cemex S.A.B. de C.V.**]
3) [**Fairborn Cement Company**]
4) [**Heidelberg Materials**]
5) [**Holcim (US) Inc**]
6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.

J. Preblended Dry Mortar Mix: Packaged blend complying with ASTM C1714/C1714M.

1. Preblended Dry Portland Cement Mortar Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**Quikrete; The QUIKRETE Companies, LLC**]
3) [**Sakrete; CRH Americas, Oldcastle APG**]
4) [**SPEC MIX, LLC**]

b. Dry Mortar Mix Materials: Made from [**portland cement-lime mix**][**masonry cement**][**or**][**mortar cement**] sand, [**mortar pigments**][**water repellent admixture**] .

2. Preblended Dry Masonry Cement Mortar Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]

2) [**SPEC MIX, LLC**]

K. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6.4 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

L. Latex Additive: Manufacturer's standard emulsion, serving as replacement for part or all of gauging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**BASF**]
b. [**Custom Building Products**]
c. [**Euclid Chemical**]
d. [**H.B. Fuller Construction Products Inc. / TEC**]
e. [**Laticrete International, Inc.**]
f. [**MAPEI Corporation**]

M. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture, complying with [**ASTM C494/C494M, Type C**][**ASTM C1384**] , and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**GCP Applied Technologies Inc.**]

N. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ACM Chemistries**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**GCP Applied Technologies Inc.**]
d. [**Master Builders Solutions**]

O. Water: Potable.

2.6 TIES AND ANCHORS

A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into veneer but with at least a **5/8-inch (16-mm)** cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, [**Type 304**][**Type 316**] .
4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] .

C. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 13 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.0336-inch- (0.85-mm-) thick, steel sheet, galvanized after fabrication**][**0.0635-inch- (1.61-mm-) thick, steel sheet, galvanized after fabrication**][**0.0312-inch- (0.79-mm-) thick, stainless steel sheet**][**0.0625-inch- (1.59-mm-) thick, stainless steel sheet**] .

D. Adjustable Anchors for Connecting to Structural-Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch- (6.4-mm-)** diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]

E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: [**Dovetail**][**Channel**] tabs for inserting into [**dovetail**][**channel**] slots in concrete and attached to tie section; formed from [**0.060-inch- (1.52-mm-) thick, steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick, steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] .

   a. [**0.064-inch- (1.63-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized-steel sheet may be used at interior walls unless otherwise indicated.

2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
3. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 13 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.0635-inch- (1.61-mm-) thick steel sheet, galvanized after**

fabrication][**0.0785-inch- (1.99-mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0625-inch- (1.59-mm-) thick, stainless steel sheet**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] with [**dovetail**][**channel**] tabs for inserting into dovetail slots in concrete.

a. [**0.064-inch- (1.63-mm-)**][**0.079-inch- (2.01-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized sheet may be used at interior walls unless otherwise indicated.

F. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a **100 lbf (445 N)** load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of **1/16 inch (1.6 mm)**.
2. Fabricate sheet metal anchor sections and other sheet metal parts from [**0.0785-inch- (1.99-mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] .
3. Fabricate wire ties from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie [**and washer at face of insulation**] .

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**FERO Corporation**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**PROSOCO, Inc**]
      4) [**Wire-Bond**]

6. Masonry-Veneer Anchors; Double-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting horizontal leg with slots for vertical legs of double pintle wire tie.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Heckmann Building Products, Inc.**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**Quality Steel and Wire LLC**]
      4) [**Wire-Bond**]

   b. Seismic: Provide seismic tie, clip, and continuous wire in veneer.

7. Masonry-Veneer Anchors; Slotted Plate: Sheet metal anchor section, with screw holes at top and bottom; and raised rib-stiffened strap, stamped into center to provide a slot between strap and

base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Quality Steel and Wire LLC**]
4) [**Wire-Bond**]

8. Masonry-Veneer Anchors; Slotted Plate with Prongs: Sheet metal anchor section, with screw holes at top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

9. Masonry-Veneer Anchors; Single-Barrel Screw: Self-drilling, single-barrel screw designed to receive wire tie. Screw has a smooth barrel the same thickness as insulation.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**PROSOCO, Inc**]
4) [**TRUFAST Walls**]
5) [**Wire-Bond**]

b. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
c. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

10. Masonry-Veneer Anchors; Single-Barrel Screw with Double-Pintle Wingnut: Self-drilling, single-barrel screw with wingnut or clip designed to receive double-pintle wire tie. Screw has a smooth barrel the same thickness as insulation.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]

b. Fastener Configuration: Single-barrel screw with [**wingnut head**][**thermally resistant wingnut head**][**thermally resistant clip**] .
c. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
d. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

11. Masonry-Veneer Anchors; Seismic-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting leg with slotted hole for vertical leg of seismic pintle tie. Tie is rib-stiffened, sheet metal bent plate with down-turned leg to fit in anchor slot and with integral tabs to hold continuous wire in veneer.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

12. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours in accordance with ASTM B117.
13. Stainless Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon steel drill point and 300 Series stainless steel shank.

2.7 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cheney Flashing Company**]
b. [**Hohmann & Barnard, Inc**]
c. [**Keystone Flashing Company, Inc**]
d. [**Wire-Bond**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
3. Copper: [**ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. (4.9 kg/sq. m) weight or 0.0216 inch (0.55 mm) thick**][**or**][**ASTM B370, Temper H01, high-yield copper sheet, 12 oz./sq. ft. (3.7 kg/sq. m) weight or 0.0162 inch (0.41 mm) thick**] .
4. Fabricate continuous flashings in sections **96 inches (2438 mm)** long minimum, but not

exceeding 12 ft. (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.

5. Fabricate through-wall metal flashing embedded in masonry from [**stainless steel**][**copper**] , with ribs at 3-inch (76-mm) intervals along length of flashing to provide an integral mortar bond.
6. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
7. Fabricate through-wall flashing with drip edge [**where**][**unless otherwise**] indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
8. Fabricate through-wall flashing with sealant stop [**where**][**unless otherwise**] indicated. Fabricate by bending metal back on itself 3/4 inch (19 mm) at exterior face of wall and down into joint 1/4 inch (6.4 mm) to form a stop for retaining sealant backer rod.
9. Fabricate metal [**drip edges**][**and**][**sealant stops**] for sawtooth metal flashing from plain metal flashing of same metal as sawtooth flashing and extending at least 3 inches (76 mm) into wall with hemmed inner edge to receive sawtooth flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
10. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
11. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 1/4 inch (6.4 mm) to form a stop for retaining sealant backer rod.
12. Fabricate metal expansion-joint strips from [**stainless steel**][**copper**] to shapes indicated.
13. Solder metal items at corners.

B. Flexible Flashing: Where flashing is fully concealed in masonry, use one of the following unless otherwise indicated:

1. Copper Fabric Flashing: Copper sheet bonded between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**Advanced Building Products Inc.**]
        2) [**Hohmann & Barnard, Inc**]
        3) [**STS Coatings, Inc.**]
        4) [**Wire-Bond**]
        5) [**York Manufacturing, Inc**]

    b. Sheet Weight: [3 oz./sq. ft. (0.9 kg/sq. m)][5 oz./sq. ft. (1.5 kg/sq. m)][7 oz./sq. ft. (2 kg/sq. m)] .
    c. Sheet Type: [**Non-adhesive**][**Self-adhesive**] .

2. Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum 2-mil (0.05-mm) thick stainless steel sheet, bonded to a layer of polymeric fabric.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
        2) [**Hohmann & Barnard, Inc**]

3) [**PROSOCO, Inc**]
4) [**STS Coatings, Inc.**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Overall Thickness: Manufacturer's standard.

3. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil (0.05-mm)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**STS Coatings, Inc.**]
3) [**VaproShield LLC**]
4) [**Wire-Bond**]
5) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Bonding Agent: [**Butyl**][**Permanent, clear**] adhesive.
d. Overall Thickness: Manufacturer's standard.

4. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Carlisle Coatings & Waterproofing Inc**]
3) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
4) [**GCP Applied Technologies Inc.**]
5) [**Heckmann Building Products, Inc.**]
6) [**Hohmann & Barnard, Inc**]
7) [**Polyguard Products, Inc.**]
8) [**W. R. Meadows, Inc**]
9) [**Williams Products, Inc.**]
10) [**Wire-Bond**]
11) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**30 mils (0.76 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] .

5. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**DuPont de Nemours, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**Kingspan Insulation LLC**]
4) [**Protecto Wrap Company**]
5) [**Viaflex**]
6) [**Wire-Bond**]

b. Overall Thickness: Not less than [**35 mils (0.89 mm)**][**40 mils (1.0 mm)**] .

6. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Hyload; IKO Industries, Inc.**]
3) [**Mortar Net Solutions**]
4) [**Wire-Bond**]

b. Monolithic Sheet: Elastomeric thermoplastic flashing, **40 mils (1.0 mm)** thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, **25 mils (0.64 mm)** thick, with a **15-mil- (0.38-mm-)** thick coating of adhesive.

1) Color: [**Gray**][**White**][**Tan/buff**][**Black**] .

7. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Carlisle Coatings & Waterproofing Inc**]
2) [**Elevate; Amrize Building Envelope LLC**]
3) [**Heckmann Building Products, Inc.**]
4) [**Hohmann & Barnard, Inc**]
5) [**Wire-Bond**]

b. Thickness: **40 mils (1.0 mm)**.

C. Drainage Plane Flashing: Provide flashing materials as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Mortar Net Solutions**]
b. [**STS Coatings, Inc.**]
c. [**York Manufacturing, Inc**]

2. Fabrication: [**Stainless steel**][**Copper**][**Rubberized asphalt**][**Elastomeric membrane**] and drainage membrane to shapes indicated [**including weep tabs, termination bar, and drip edge**] .

   a. Stainless Steel: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
   b. Copper: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**] thick.
   c. Rubberized Asphalt: [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.
   d. Elastomeric Membrane: [**EPDM, complying with ASTM D4637/D4637M**][**PVC**][**PVC with Elvaloy Kee**][**TPO**] , [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.

3. Fabricate continuous flashings in sections **60 inches (1524 mm)** long, minimum.
4. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

D. Preformed Corners, End Dams, and Seaming Shapes for Flashing: Flashing manufacturer's standard products or products recommended by flashing manufacturer for waterproofing openings.

E. Solder and Sealants for Sheet Metal Flashings: [**As specified in Section 076200 "Sheet Metal Flashing and Trim."**]

1. Solder for Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
2. Solder for Copper: ASTM B32, [**Grade Sn50**][**with maximum lead content of 0.2 percent**] .
3. Elastomeric Sealant: ASTM C920, chemically curing [**urethane**][**polysulfide**][**silicone**] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

F. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

G. Termination Bars for Flexible Flashing:

1. Material: [**Aluminum**][**Stainless steel**][**Rigid PVC**] .
2. Size: [**0.075 by 1 inch (1.90 by 25 mm)**][**1/8 by 1 inch (3.2 by 25 mm)**][**1/8 by 1-1/8 inch (3.2 by 29 mm)**] .

H. Termination Bars for Flexible Flashing, Flanged:

1. Material: [**Stainless steel sheet 0.019 by 1-1/2 inches (0.48 by 38 mm)**][**Aluminum sheet 0.064 by 1-1/2 inches (1.63 by 38 mm)**] .
2. Fabricate with a **3/8-inch (10-mm)** flange at top [**and bottom**] .

2.8 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [**neoprene**][**urethane**][**or**][**PVC**] .

B. Weep/Vent Products: Use the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton, **1/4 to 3/8 inch (6.4 to 10 mm)** in diameter, in length required to produce **2-inch (51-mm)** exposure on exterior and **18 inches (457 mm)** in cavity. Use only for weeps.
2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, **3/8-inch (10-mm)** OD by **4 inches (102 mm)** long.
3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, **3/8 by 1-1/2 by 3-1/2 inches (10 by 38 by 89 mm)** long.
4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe, in color selected from manufacturer's standard.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**Advanced Building Products Inc.**]
        2) [**Heckmann Building Products, Inc.**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**Mortar Net Solutions**]
        5) [**Wire-Bond**]

5. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe; in color selected from manufacturer's standard.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**CavClear; a division of Archovations, Inc.**]
        2) [**Hohmann & Barnard, Inc**]
        3) [**Keene Building Products**]
        4) [**Mortar Net Solutions**]

6. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**Hohmann & Barnard, Inc**]

2) [**Williams Products, Inc.**]
3) [**Wire-Bond**]

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Mortar Deflector:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Size: Strips [**full depth of cavity**][**3/4 inch (19 mm) thick**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] and [**10 inches (254 mm)**][**16 inches (406 mm)**] high.
c. Surface Drainage: [**Dovetail-shaped notches**][**Dimpled surface**] that prevents clogging with mortar droppings.

2. Rainscreen Drainage Mat:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**CavClear; a division of Archovations, Inc.**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]

b. Size: Sheets or strips not less than [**full depth of cavity**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] thick and installed to full height of cavity.
c. Surface Drainage: Provide additional strips **4 inches (102 mm)** high at weep holes and thick enough to fill entire depth of cavity to prevent weep holes from clogging with mortar.

D. Offset Angle Supports: Steel plate brackets anchored to structure, allowing continuous insulation behind shelf angle supporting veneer for thermal bridging. Component and anchor size and spacing engineered by manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**FERO Corporation**]
b. [**Halfen USA, Inc.**]
c. [**Hohmann & Barnard, Inc**]

E. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**EaCo Chem, Inc.**]
c. [**PROSOCO, Inc**]

F. Modular Panel System: Manufacturer's approved modular panels designed for adhering thin brick units or mechanically securing thin brick to the panel with attachment hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Brick Company**]
b. [**Tabs Wall Systems, LLC**]

2. Panel Type: Use [**Metal, G90 galvanized steel 0.018 inch (0.46 mm) thick, structural Grade 33 steel**][**Composite made of polypropylene and fiberglass**] .

G. Expanded Metal Lath: **3.4 lb/sq. yd. (1.8 kg/sq. m)**, self-furring, diamond-mesh lath complying with ASTM C847. Fabricate from structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, **G60 (Z180)**.

H. Woven-Wire Lath: ASTM C1032/C1032M, fabricated into **1-1/2-inch (38-mm)** hexagonal-shaped mesh with minimum **0.0510-inch- (1.3-mm-)** diameter, galvanized-steel wire.

I. Welded-Wire Lath: ASTM C933, fabricated into **2-by-2-inch (50-by-50-mm)** mesh with minimum **0.0625-inch- (1.6-mm-)** diameter, galvanized-steel wire.

J. Lath Attachment Devices and Fasteners: Corrosion-resistant material and type required by ASTM C1063 for installations indicated.

K. Weep Screed: Fabricated from hot-dip galvanized steel sheet ASTM A653/ASTMA653M, **G60 (Z180)** zinc coating.

2.9 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar unless otherwise indicated.
3. For exterior masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
4. For reinforced masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Masonry Veneer: Comply with ASTM C270, [**Proportion**][**Property**] Specification. Use Type N unless another type is indicated.

1. For masonry below grade or in contact with earth, use [**Type M**][**Type S**] .

D. Pigmented Mortar: Use colored cement product [**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored mortar cement**] .

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.
3. Mix to match Architect's sample, as directed by the Owner.
4. Application: Use pigmented mortar for exposed mortar joints.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample, as directed by the Owner.
2. Application: Use colored-aggregate mortar for exposed mortar joints.

F. Thinset Mortar: Polymer-modified, thinset mortar per ANSI A118.4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install all accessories in accordance with manufacturer's written instructions.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

D. Select and arrange units for exposed masonry veneer to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

E. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (13 mm)** or minus **1/4 inch (6.4 mm)**.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (13 mm)**.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6.4 mm)** in a story height or **1/2 inch (13 mm)** total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.6 mm)** except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**, with a maximum thickness limited to **1/2 inch (13 mm)**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3.2 mm)**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (10 mm)** or minus **1/4 inch (6.4 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**. [**Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3.2 mm).**]
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than **1/16 inch (1.6 mm)** from one masonry unit to the next.

3.4 INSTALLATION OF MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [**running bond**][**stack bond**][**one-third running bond**][**Flemish bond**][**English bond**][**bond pattern indicated on Drawings**] ; do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

3.5 INSTALLATION OF MORTAR BEDDING AND JOINTING

A. Lay masonry units with face shells fully bedded in mortar and with head joints of depth equal to bed joints. At starting course, fully bed entire units, including area under cells.

1. At anchors and ties, fully bed units and fill cells with mortar as needed to fully embed anchors and ties in mortar.

B. Hollow Clay Facing Brick: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Solid Masonry Units: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

D. Trim Units: Set [**stone**][**cast-stone**] trim units in full bed of mortar with full vertical joints.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.
4. Rake out mortar joints for pointing with sealant.

E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness

unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer **3/4 inch (19 mm)** or more in width.

3.6 INSTALLATION OF ANCHORED MASONRY VENEERS

A. Masonry-veneer anchors to comply with the following requirements:

1. Fasten [**screw-attached**][**and**][**seismic**] anchors [**through sheathing to wall framing**][**and**][**to concrete and masonry backup**] with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed [**tie sections**][**connector sections and continuous wire**] in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and **24 inches (610 mm)** o.c. horizontally, with not less than one anchor for each **2 sq. ft. (0.2 sq. m)** of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **8 inches (203 mm)**, around perimeter.
5. Space anchors as indicated, but not more than **16 inches (406 mm)** o.c. vertically and **25 inches (635 mm)** o.c. horizontally, with not less than one anchor for each [**2.67 sq. ft. (0.25 sq. m)**][**3.5 sq. ft. (0.33 sq. m)**] of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **36 inches (914 mm)**, around perimeter.
6. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and horizontally. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **24 inches (610 mm)**, around perimeter.

B. Provide not less than [**2 inches (51 mm)**][**1 inch (25 mm)**] of airspace between back of masonry veneer and face of [**sheathing**][**insulation**] .

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.7 INSTALLATION OF THE ANCHORING OF MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than [**1/2 inch (13 mm)**][**1 inch (25 mm)**][**2 inches (51 mm)**] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than **24 inches (610 mm)** o.c. vertically and **36 inches (914 mm)** o.c. horizontally.

3.8 INSTALLATION OF ADHERED THIN BRICK VENEER

A. Thickset Method:

1. Mechanically fasten metal lath or mesh securely to substrate per manufacturer's written instructions.
2. Apply scratch coat and then bond coat over prepared lath or mesh.
3. Set thin brick into mortar bed, ensuring full coverage on back of thin brick units.

4. Maintain consistent spacing, coursing, joint width, and alignment.

B. Thinset Method:

1. Apply thinset latex-modified mortar to backer board as recommended in writing by manufacturer with notched trowel.
2. Set thin brick, pressing firmly into mortar for full bond.
3. Maintain consistent spacing, coursing, joint width, and alignment.

C. Modular Panel Systems:

1. General: Follow manufacturers' modular panel systems written instructions for the following:

a. Mortar: Type N or latex modified.

2. Panels and Adhesive: Per panel manufacturer's written instructions.
3. Interior Applications:

a. Install, secure and prepare modular panels per manufacturer's written instructions.
b. Provide polymer-modified mortar as recommended in writing by thin brick manufacturer.
c. Trowel the mortar onto the panel and expose the coursing on the modular panel.
d. Back face of thin brick must be dry and clean, free of dirt, oil, or any other foreign contaminant.
e. Apply a uniform layer of mortar to the entire back surface of each thin brick with notched trowel immediately prior to setting.
f. Place thin veneer on the panel leg and bag in joints with Type N or Type S mortar.
g. Strike joints using a joint profile tool.

4. Exterior Applications:

a. Install, secure and prepare modular panels per manufacturer's written instructions.
b. Back face of thin brick must be dry and clean, free of dirt, oil, or any other foreign contaminant.
c. Where applicable, insert thin brick into panel grooves, rails, or tabs to support and align thin brick courses.
d. Where panel requires mortar method installation, trowel the scratch coat onto the panel and expose the coursing on the modular panel.
e. Thin brick to be applied within 10 minutes after thinset adhesive has been applied and before film begins to form on the thinset adhesive.
f. Lay thin brick in course pattern as indicated on Drawings.
g. Leave a uniform **3/8- to 1/2-inch (9.5- to 12.7-mm)** gap at openings to allow for movement joint installation.
h. Keep areas intended to receive sealant clean of thin brick, adhesive, and other materials during construction.
i. Place thin brick on the panel leg and bag in joints with Type N or Type S mortar.
j. Strike joints using a joint profile tool.
k. Do not allow masonry units to bridge movement joints in substrate.

3.9 INSTALLATION OF ADHERED THIN CMU VENEER

A. General: Construct thin CMU in compliance with TMS 402/602.

B. Mechanically fasten metal lath or mesh securely to moisture-resistant substrate per manufacturer's written instructions.

C. Apply ANSI A118.4 mortar scratch coat over prepared lath or mesh.

D. Horizontally score mortar surface while plastic to form mechanical key.

E. Brush neat portland cement paste onto both the scratch coat surface and the back of the thin CMU unit completely.

F. Maintain consistent spacing, coursing, joint width, and alignment.

G. Press, tap veneer units into place, and bed firmly to achieve **3/8-inch (9-mm)** minimum to **1-1/4-inch (302-mm)** maximum mortar behind the units after setting.

H. Ensure full continuous contact without gaps behind the veneer units.

I. Tool joints with a round jointer when mortar is thumbprint hard for uniform appearance.

J. Remove and clean excess mortar promptly.

K. Grout the joints only after there is sufficient cure time of installing thin CMU units, when mild contact will not break the bonding.

L. Extra precaution should be taken while raking the joints to desired depth so the surface of the thin CMU is undamaged. Clean off remaining grout debris on the thin CMU surface with a dry, soft-bristled brush.

M. See thin CMU manufacturer's written instructions on cleaning and maintenance. Do not use harsh chemicals for cleaning, such as muriatic acid, or abusive tools, such as wire brushes to clean the surface.

3.10 INSTALLATION OF EXPANSION JOINTS

A. General: Install expansion-joint materials in masonry veneer as masonry progresses. Do not allow materials to span expansion joints without provision to allow for in-plane wall or partition movement.

B. Form expansion joints as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint **4 inches (102 mm)** in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**] for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

C. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than [**3/8 inch (10 mm)**] .

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.11 INSTALLATION OF OFFSET ANGLE SUPPORTS

A. Provide offset angle supports where indicate and where openings of more than **12 inches (305 mm)** for brick-size units and **24 inches (610 mm)** for block-size units are indicated without structural steel or other supporting lintels.

B. Provide minimum bearing of **8 inches (203 mm)** at each jamb unless otherwise indicated.

3.12 INSTALLATION OF EMBEDDED FLASHING

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. [**Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.**]

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape [**as recommended by flashing manufacturer**] .
2. Extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least **8 inches (203 mm)**; with upper edge tucked under [**water-resistive barrier**][**air barrier**] , lapping at least **4 inches (102 mm)**. [**Fasten upper edge of flexible flashing to sheathing through termination bar.**]
3. At lintels and shelf angles, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] at each end. At heads and sills, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] and turn ends up not less than **2 inches (51 mm)** to form end dams.
4. Interlock end joints of sawtooth sheet metal flashing by overlapping ribs not less than **1-1/2 inches (38 mm)** or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
5. Install metal [**drip edges**][**and**][**sealant stops**] with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
7. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.

3.13 INSTALLATION OF WEEP/CAVITY VENTS

A. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use [**specified weep/cavity vents**][**or**][**open-head joints**] to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes **24 inches (610 mm)** o.c. unless otherwise indicated.
4. Space weep holes formed from [**plastic tubing**][**or**][**wicking material**] **16 inches (406 mm)** o.c.

5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Trim wicking material flush with outside face of wall after mortar has set.

B. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

C. Install vents in head joints in exterior wythes at spacing indicated. Use [**specified weep/cavity vent products**][**or**][**open-head joints**] to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Inspections: Special inspections in accordance with Level 2 in TMS 402/602.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

C. Testing Prior to Construction: One set of tests.

D. Clay Masonry Units: Test each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

E. Concrete Masonry Units: Test each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Mortar Aggregates: Ratio test (proportion specification) for each mix provided, in accordance with ASTM C780.

G. Mortar: Test each mix provided, in accordance with ASTM C780. Test mortar for [**mortar air content**][**and**][**compressive strength**] .

3.15 REPAIRING AND POINTING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

3.16 CLEANING

A. In-Progress Cleaning: Clean masonry veneer as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes, as directed by the Owner.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied in accordance with manufacturer's written instructions.

3.17 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of masonry veneer work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than **4 inches (102 mm)** in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within **18 inches (457 mm)** of finished grade.

C. Masonry Waste Recycling: Return broken masonry units not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, as directed by the Owner.

END OF SECTION 04 20 00 00A

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Task	Specification	Specification Description
04 21 00 00	04 20 00 00a	Masonry Veneer
04 21 13 00	04 20 00 00	Unit Masonry
04 21 13 00	04 20 00 00a	Masonry Veneer
04 21 19 00	04 20 00 00	Unit Masonry
04 21 19 00	04 20 00 00a	Masonry Veneer
04 21 26 00	04 20 00 00	Unit Masonry
04 21 26 00	04 20 00 00a	Masonry Veneer
04 21 29 00	04 20 00 00	Unit Masonry
04 21 29 00	04 20 00 00a	Masonry Veneer

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SECTION 04 22 00 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Lintels.
3. Mortar and grout materials.
4. Reinforcement.
5. Ties and anchors.
6. Embedded flashing.
7. Accessories.
8. Mortar and grout mixes.

B. Products Installed, but Not Furnished, under This Section:

1. Precast architectural concrete trim in concrete unit masonry.
2. Glass unit masonry in concrete unit masonry.
3. Brick veneer in concrete unit masonry.
4. Cast-stone trim in concrete unit masonry.
5. Steel lintels in concrete unit masonry.
6. Steel shelf angles for supporting concrete unit masonry.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for [**installing**] dovetail slots for masonry anchors.
2. Section 034500 "Precast Architectural Concrete" for precast concrete trim.
3. Section 042300 "Glass Unit Masonry" for glass block.
4. Section 042613 "Masonry Veneer" for unit masonry set as veneer.
5. Section 047200 "Cast Stone Masonry" for cast stone trim units.
6. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
7. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles.
8. Section 071900 "Water Repellents" for water repellents applied to surface of unit masonry assemblies.
9. Section 072119 "Foamed-in-Place Insulation" for foam insulation installed in CMU cores.
10. Section 076200 "Sheet Metal Flashing and Trim" for [**exposed**] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
11. Section 323223 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

C. Exposed: Weather-exposed side of a constructed wall.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI PRC 315R. [**Indicate elevations of reinforced walls.**]
3. Lintel design and types required.
4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Colored Mortar: Full range of manufacturer's standard colors.
4. Aggregate for Mortar: Range of aggregate colors for colored-aggregate mortar.

D. Samples for Verification: For each type and color of the following:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Colored mortar.
4. Pigmented Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
5. Colored-Aggregate Mortar: Make Samples using same sand and mortar ingredients to be used on Project.

E. Sustainable Design Submittals:

1. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
2. Type III Environmental Product Declaration (EPD): For each product.
3. Type III Environmental Product Declaration (EPD): For each product.
4. Multi-Attribute Optimization: For each product, provide documentation of third-party certification, indicating impact reduction in global warming potential, depletion of stratospheric ozone layer, acidification of land and water sources, eutrophication, and/or formation of tropospheric ozone.
5. Multi-Attribute Optimization: For each product, provide documentation of third-party certification, indicating impact reduction in global warming potential, depletion of stratospheric ozone layer, acidification of land and water sources, eutrophication, and/or formation of tropospheric ozone.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include [**data on material properties**][**material test reports substantiating compliance with requirements**][**documentation of carbon-reduction methods**] .
b. For masonry units [**used in structural masonry**] , include data and calculations establishing average net-area compressive strength of units.

2. Integral water repellent used in CMUs, if not surface treated.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

B. Mix Designs: For each type of mortar [**and grout**] . Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

C. Qualification Statements: For testing agency.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 402/602.

E. Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements for [**cold**][**and**][**hot**] weather.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 MOCKUPS

A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1200 mm)**][**60 inches (1500 mm)**] long by [**36 inches (900 mm)**][**48 inches (1200 mm)**] high [**by full thickness**] .
2. Build sample panels facing south.

3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of panels with masonry cleaner indicated.
5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing, as directed by the Owner.

B. Wall Mockups: Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**and**][**to set quality standards for installation**] .

1. Build mockup [**as indicated on Drawings**] .
2. Build mockups for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1200 mm)**][**60 inches (1500 mm)**][**72 inches (1800 mm)**][**96 inches (2400 mm)**] long by [**36 inches (900 mm)**][**48 inches (1200 mm)**][**60 inches (1500 mm)**][**72 inches (1800 mm)**] high by full thickness, including face and backup wythes and accessories.

    a. Include a sealant-filled joint at least **16 inches (406 mm)** long in [**each**][**exterior wall**] mockup.
    b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately **12 inches (305 mm)** wide by **16 inches (406 mm)** high.
    c. Include through-wall flashing installed for a **24-inch (600-mm)** length in corner of exterior wall mockup approximately **16 inches (406 mm)** down from top of mockup, with a **12-inch (305-mm)** length of flashing left exposed to view (omit masonry above half of flashing).

3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of mockups with masonry cleaner as indicated.
5. Protect accepted mockups from the elements with weather-resistant membrane.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof

sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of **24 inches (600 mm)** down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**exposed masonry units**][**cementitious mortar components**][**and**][**mortar aggregate**] from single [**source**][**producer**] [**manufacturer**] .

B. For [**exposed masonry units**][**and**][**cementitious mortar components**] , obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Provide [**structural**] unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 402/602.
2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 CONCRETE UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 402/602 except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work [**and will be within 20 ft. (6 m) vertically and horizontally of a walking surface**] .

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, [**use the equivalent thickness method for masonry units in accordance with Tech Note TEK 07-01D**][**units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction**] .

2.4 CONCRETE MASONRY UNITS

A. Regional Materials: Verify CMUs are manufactured within **100 miles (160 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify CMUs are manufactured within **500 miles (800 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide [**square-edged**][**bullnose**] units for outside corners unless otherwise indicated.

D. CMUs: ASTM C90, [**normal weight**][**medium weight**][**lightweight**][**unless otherwise indicated**] .

1. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less-than-nominal dimensions.
2. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
3. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

E. Architectural CMUs: ASTM C90, [**normal-weight**][**medium-weight**][**lightweight**] architectural units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Angelus Block Co., Inc.**]
b. [**Echelon Masonry, an Oldcastle APG brand**]
c. [**York Building Products**]

2. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less-than-nominal dimensions.
3. Pattern and Texture: [**Standard pattern, ground-face finish**][**Standard pattern, split-face finish**][**Standard pattern, split-ribbed finish**][**Scored vertically to appear square in stacked bond, standard finish**][**Triple scored vertically to appear as soldier courses in stacked bond, standard finish**] . [**Match Architect's samples.**]
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.

F. Prefaced CMUs: ASTM C90, lightweight, with manufacturer's standard smooth resinous facing complying with ASTM C744.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Echelon; an Oldcastle APG brand**]
   b. [**York Building Products**]

2. Composition: [**Hollow**][**Solid**] units.
3. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.5-mm-)** wide returns of facing to create **1/4-inch- (6-mm-)** wide mortar joints with modular coursing.
4. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

G. Acoustical CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] sound-absorbing units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Echelon; an Oldcastle APG brand**]
   c. [**RPG Acoustical Systems, Inc.**]
   d. [**Sound Seal**]

2. Surface Characteristics: [**Slotted**][**Textured**] .
3. Cavity Fill: [**Fibrous filler**][**Galvanized steel septum**][**Unfilled**].
4. Sound Transmission Classification (STC): minimum as measured [**by an independent, accredited NVLAP facility**] in accordance with ASTM E90 and ASTM E413.
5. Noise Reduction Coefficient (NRC): In accordance with ASTM C423 and ASTM E795.

H. Rigid, Cellular Thermal Insulation CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units containing rigid, specially shaped, molded-polystyrene insulation complying with ASTM C578, Type I, designed for installing in cores of CMUs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Concrete Block Insulating Systems**]

b. [**Echelon Masonry, an Oldcastle APG brand**]
c. [**Shelter Enterprises Inc.**]
d. [**York Building Products**]

2. Size: Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

I. Low-Carbon CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units with low embodied carbon.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CarbonBuilt**]
b. [**CarbonCure**]
c. [**CarbonKind**]
d. [**CarbonX**]
e. [**Pozzotive (Glenwood Mason Supply)**]

2. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.5-mm-)** wide returns of facing to create **1/4-inch- (6-mm-)** wide mortar joints with modular coursing.
3. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

J. Concrete Building Brick: ASTM C55, [**normal-weight**][**medium-weight**][**lightweight**] solid units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Brick Company**]
b. [**Belden Brick Company (The)**]
c. [**Bilco Brick Company**]
d. [**Echelon Masonry, an Oldcastle APG brand**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**] high by **7-5/8 inches (194 mm)** long.

K. CMU Admixtures:

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, will show no visible water or leaks on the back of test specimen.

a. Location: [**For exposed units**][**and**][**where indicated on Drawings**] .

2.5 LINTELS

A. Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. [**Provide lintels with net-area compressive strength of not less than that of CMUs.**][**Provide lintels with net-area compressive strength as indicated.**]

B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete" and with reinforcing bars indicated.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 MORTAR AND GROUT MATERIALS

A. Regional Materials: Verify aggregate for mortar and grout [**, cement, and lime**] is manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify aggregate for mortar and grout [**, cement, and lime**] is manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide mortar and grout materials to achieve performance requirements as specified in mortar and grout mixes.

D. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.

E. Hydrated Lime: ASTM C207, Type S.

F. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

G. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Argos USA LLC**]
b. [**Cemex S.A.B. de C.V.**]
c. [**Fairborn Cement Company**]
d. [**Federal White Cement, Ltd.**]
e. [**Heidelberg Materials**]
f. [**Holcim (US) Inc**]
g. [**Lafarge North America Inc.**]
h. [**Lehigh White Cement Company**]
i. [**Quikrete; The QUIKRETE Companies, LLC**]

j. [**Sakrete; CRH Americas, Oldcastle APG**]

H. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Lafarge North America Inc.**]

I. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Davis Colors**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Lanxess Corporation**]
d. [**Solomon Colors Inc.**]

J. Colored Mortar: Packaged blend made from [**portland cement-lime mix lime**] [**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Heidelberg Materials**]
3) [**Holcim (US) Inc**]
4) [**Lafarge North America Inc.**]

2. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Cemex S.A.B. de C.V.**]
3) [**Fairborn Cement Company**]
4) [**Heidelberg Materials**]

5) [**Holcim (US) Inc**]
6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments does not exceed 10 percent of portland cement by weight.
5. Pigments does not exceed 5 percent of [**masonry cement**] [**mortar cement**] by weight.

K. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

L. Aggregate for Grout: ASTM C404.

M. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or prefaced masonry units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

N. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**GCP Applied Technologies Inc.**]

O. Water-Repellent Mortar Admixture: Liquid water-repellent admixture added to mortar, intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ACM Chemistries**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**GCP Applied Technologies Inc.**]
d. [**Master Builders Solutions**]

P. Water: Potable.

2.7 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60 (Grade 420)**.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from **0.148-inch (3.77-mm)** steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Heckmann Building Products, Inc.**]
   b. [**Hohmann & Barnard, Inc**]
   c. [**Wire-Bond**]

C. Masonry-Joint Reinforcement: Ladder type complying with ASTM A951/A951M.

1. Interior Walls: [**Mill-**][**Hot-dip**] galvanized carbon steel.
2. Exterior Walls: [**Hot-dip galvanized carbon**][**Stainless**] steel.
3. Wire Size for Side Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
4. Wire Size for Cross Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
5. Spacing of Cross Rods: Not more than **16 inches (406 mm)** o.c.
6. Provide in lengths of not less than **10 ft. (3 m)**[**, with prefabricated corner and tee units**] .

2.8 TIES AND ANCHORS

A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into masonry but with at least a **5/8-inch (16-mm)** cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, [**Type 304**][**Type 316**] .
4. Mill Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M commercial steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] .
7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch- (6-mm-)** diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.35-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be**

used at interior walls unless otherwise indicated.]

D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from [**0.060-inch- (1.52-mm-) thick steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] .

   a. [**0.064-inch- (1.63-mm-)**][**0.108-inch- (2.74-mm-)**] thick, hot-dip galvanized-steel sheet may be used at interior walls unless otherwise indicated.

2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.35-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized carbon steel wire may be used at interior walls unless otherwise indicated.**]
3. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 12.7 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.060-inch- (1.52-mm-) thick steel sheet, galvanized after fabrication**][**0.075-inch- (1.90 mm-) thick steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.078-inch- (1.98-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] with dovetail tabs for inserting into dovetail slots in concrete.

   a. [**0.064-inch- (1.63-mm-)**][**0.079-inch- (2.01-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized sheet may be used at interior walls unless otherwise indicated.

E. Partition Top Anchors: **0.105-inch- (2.66-mm-)** thick metal plate with a **3/8-inch- (9.5-mm-)** diameter metal rod **6 inches (152 mm)** long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from [**steel, hot-dip galvanized after fabrication**][**stainless steel**] .

F. Rigid Anchors: Fabricate from steel bars [**1-1/2 inches (38 mm) wide by 1/4 inch (6 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated**][**bent to configuration indicated**] .

1. Corrosion Protection: [**Hot-dip galvanized to comply with ASTMA 153/A153M**][**Epoxy coating 0.020 inch (0.51 mm) thick**][**Rust-inhibitive paint**] .

2.9 EMBEDDED FLASHING

A. Embedded Flashing Applications: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing [**with a drip edge**][**with a sealant stop**][**or flexible flashing with a metal drip edge**][**or elastomeric thermoplastic flashing with a drip edge**][**or flexible flashing with a metal sealant stop**] .
4. Where flashing is fully concealed, use [**metal flashing**] [**flexible flashing**] .

B. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual":

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Cheney Flashing Company**]
    b. [**Hohmann & Barnard, Inc**]
    c. [**Keystone Flashing Company, Inc**]
    d. [**Wire-Bond**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
3. Copper: [**ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. (4.9 kg/sq. m) weight or 0.0216 inch (0.55 mm) thick**] [**ASTM B370, Temper H01, high-yield copper sheet, 12 oz./sq. ft. (3.7 kg/sq. m) weight or 0.0162 inch (0.41 mm) thick**] .
4. Fabricate continuous flashings in sections **96 inches (2400 mm)** long minimum, but not exceeding **12 ft. (3.7 m)**. Provide splice plates at joints of formed, smooth metal flashing.
5. Fabricate through-wall metal flashing embedded in masonry from [**stainless steel**][**copper**] , with ribs at **3-inch (76-mm)** intervals along length of flashing to provide an integral mortar bond.
6. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
7. Fabricate through-wall flashing with drip edge [**where**][**unless otherwise**] indicated. Fabricate by extending flashing **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
8. Fabricate through-wall flashing with sealant stop [**where**][**unless otherwise**] indicated. Fabricate by bending metal back on itself **3/4 inch (19 mm)** at exterior face of wall and down into joint **1/4 inch (6 mm)** to form a stop for retaining sealant backer rod.
9. Fabricate metal [**drip edges**][**and**][**sealant stops**] for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least **3 inches (76 mm)** into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.

C. Flexible Flashing: Where flashing is fully concealed in masonry, use one of the following unless otherwise indicated:

1. Copper-Fabric Flashing: Copper sheet bonded between two layers of glass-fiber cloth.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**Advanced Building Products Inc.**]
        2) [**Hohmann & Barnard, Inc**]
        3) [**STS Coatings, Inc.**]
        4) [**Wire-Bond**]
        5) [**York Manufacturing, Inc**]

    b. Sheet Weight: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .
    c. Sheet Type: [**Non-adhesive**][**Self-adhesive**] .

2. Asphalt-Coated Copper Flashing: Copper sheet coated with flexible asphalt.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

b. Sheet Weight: [**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .

3. Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
2) [**Hohmann & Barnard, Inc**]
3) [**PROSOCO, Inc**]
4) [**STS Coatings, Inc.**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Overall Thickness: Manufacturer's standard.

4. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**STS Coatings, Inc.**]
3) [**VaproShield LLC**]
4) [**Wire-Bond**]
5) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Bonding Agent: [**Butyl**][**Permanent, clear**] adhesive.
d. Overall Thickness: Manufacturer's standard.

5. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Carlisle Coatings & Waterproofing Inc**]
3) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
4) [**GCP Applied Technologies Inc.**]
5) [**Heckmann Building Products, Inc.**]
6) [**Hohmann & Barnard, Inc**]
7) [**Polyguard Products, Inc.**]
8) [**W. R. Meadows, Inc**]
9) [**Williams Products, Inc.**]
10) [**Wire-Bond**]
11) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**30 mils (0.76 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] .

6. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**DuPont de Nemours, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**Kingspan Insulation LLC**]
4) [**Protecto Wrap Company**]
5) [**Wire-Bond**]

b. Overall Thickness: Not less than [**35 mils (0.89 mm)**][**40 mils (1.0 mm)**] .

7. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Hyload; IKO Industries, Inc.**]
3) [**Mortar Net Solutions**]
4) [**Wire-Bond**]

b. Monolithic Sheet: Elastomeric thermoplastic flashing, **0.040 inch (1.02 mm)** thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, **0.025 inch (0.64 mm)** thick, with a **0.015-inch- (0.38-mm-)** thick coating of adhesive.

1) Color: [**Gray**][**White**][**Tan/buff**][**Black**] .

8. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Carlisle Coatings & Waterproofing Inc**]
      2) [**Elevate; Amrize Building Envelope LLC**]
      3) [**Heckmann Building Products, Inc.**]
      4) [**Hohmann & Barnard, Inc**]
      5) [**Wire-Bond**]

   b. Thickness: **40 mils (1.0 mm)**.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Mortar Net Solutions**]

E. Preformed Corners, End Dams, and Seaming Shapes for Flashing: Flashing manufacturer's standard products or products recommended by flashing manufacturer for waterproofing openings.

F. Solder and Sealants for Sheet Metal Flashings: [**As specified in Section 076200 "Sheet Metal Flashing and Trim."**]

1. Solder for Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
2. Solder for Copper: ASTM B32, [**Grade Sn50**][**with maximum lead content of 0.2 percent**] .
3. Elastomeric Sealant: ASTM C920, chemically curing [**urethane**][**polysulfide**][**silicone**] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

G. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.10 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [**neoprene**][**urethane**] [**PVC**] .

B. Preformed Control-Joint Gaskets: Made from [**styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805**] [**PVC, complying with ASTM D2287, Type PVC-65406**] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

D. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
    b. [**EaCo Chem, Inc.**]
    c. [**PROSOCO, Inc**]

E. Masonry-Cell Fill: [**Loose-fill insulation, perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation)**][**Lightweight-aggregate fill, ASTM C331/C331M**][**Foamed-in-place masonry cell fill**] .

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**] [**mortar cement**] mortar unless otherwise indicated.
3. For exterior masonry, use [**portland cement-lime**][**masonry cement**] [**mortar cement**] mortar.
4. For reinforced masonry, use [**portland cement-lime**][**masonry cement**] [**mortar cement**] mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, [**Proportion**][**Property**] Specification. Provide the following types of mortar for applications stated unless another type is indicated [**or needed to provide required compressive strength of masonry**] .

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use [**Type M**][**Type S**][**Type N**] .
3. For mortar parge coats, use [**Type S**] [**Type N**] .
4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product [**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products**] .

1. Pigments does not exceed 10 percent of portland cement by weight.
2. Pigments does not exceed 5 percent of [**masonry cement**] [**mortar cement**] by weight.
3. Mix to match Architect's sample.
4. Application: Use pigmented mortar for exposed mortar joints, as directed by the Owner.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints as directed by the Owner.

F. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 402/602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, [**Table 1**] [**paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa)**] .
3. Provide grout with a slump of [**8 to 11 inches (200 to 280 mm)**][**10 to 11 inches (250 to 280 mm)**] as measured in accordance with ASTM C143/C143M.

G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

1. Application: Use epoxy pointing mortar for exposed mortar joints as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that would impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow

units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

D. Exposed Masonry: Mix units to produce uniform blend of colors and textures.

E. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

F. Temperature Control: Perform temperature-sensitive construction procedures while masonry Work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within **10 deg F (6 deg C)**.

1. 40 to 32 Deg F (4 to 0 Deg C):

    a. Mortar: Heat mixing water to produce mortar temperature between **40 and 120 deg F (4 and 49 deg C)**.
    b. Grout: Follow normal masonry procedures.

2. 32 to 25 Deg F (0 to Minus 4 Deg C):

    a. Mortar: Heat mixing water and sand to produce mortar temperatures between **40 and 120 deg F (4 and 49 deg C)**; maintain temperature of mortar on boards above freezing.
    b. Grout: Heat grout materials to **90 deg F (32 deg C)** to produce in-place grout temperature of **70 deg F (21 deg C)** at end of workday.

3. 25 to 20 Deg F (Minus 4 to 7 Deg C):

    a. Mortar: Heat mixing water and sand to produce mortar temperatures between **40 and 120 deg F (4 and 49 deg C)**; maintain temperature of mortar on boards above freezing.
    b. Grout: Heat grout materials to **90 deg F (32 deg C)** to produce in-place grout temperature of **70 deg F (21 deg C)** at end of workday.
    c. Heat both sides of walls under construction using salamanders or other heat sources.
    d. Use windbreaks or enclosures when wind is in excess of 15 mph.

4. 20 Deg F (Minus 7 Deg C) and Below:

    a. Mortar: Heat mixing water and sand to produce mortar temperatures between **40 and 120 deg F (4 and 49 deg C)**.
    b. Grout: Heat grout materials to **90 deg F (32 deg C)** to produce in-place grout temperature of **70 deg F (21 deg C)** at end of workday.
    c. Masonry Units: Heat masonry units so that they are above **20 deg F (minus 7 deg C)** at time of laying.
    d. Provide enclosure and auxiliary heat to maintain an air temperature of at least **40 deg F (4 deg C)** for 24 hours after laying units.

5. Do not heat water for mortar and grout to above **160 deg F (71 deg C)**.

G. Masonry Protection: Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry, temperature ranges apply to anticipated minimum night temperatures.

1. 40 to 32 Deg F (4 to 0 Deg C): Protect masonry from rain or snow for at least 24 hours by

covering with weather-resistive membrane.

2. 32 to 25 Deg F (0 to Minus 4 Deg C): Completely cover masonry with weather-resistive membrane for at least 24 hours.
3. 25 to 20 Deg F (Minus 4 to 7 Deg C): Completely cover masonry with weather-resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
4. 20 Deg F (Minus 7 Deg C) and Below: Except as otherwise indicated, maintain masonry temperature above 32 deg F (0 deg C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry, maintain heated enclosure to **40 deg F (4 deg C)** for 48 hours.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (13 mm)** or minus **1/4 inch (6 mm)**.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (13 mm)**.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6 mm)** in a story height or **1/2 inch (13 mm)** total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 ft. (6 mm in 3 m)**, or **1/2 inch (13 mm)** maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 ft. (3 mm in 3 m)**, **1/4 inch in 20 ft. (6 mm in 6 m)**, or **1/2 inch (13 mm)** maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 ft. (6 mm in 3 m)**, **3/8 inch in 20 ft. (9 mm in 6 m)**, or **1/2 inch (13 mm)** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 ft. (3 mm in 3 m)**, **1/4 inch in 20 ft. (6 mm in 6 m)**, or **1/2 inch (13 mm)** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 ft. (6 mm in 3 m)**, **3/8 inch in 20 ft. (9 mm in 6 m)**, or **1/2 inch (13 mm)** maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 ft. (6 mm in 3 m)** or **1/2 inch (13 mm)** maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.5 mm)**.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**, with a maximum thickness limited to **1/2 inch (13 mm)**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3 mm)**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (9 mm)** or minus **1/4 inch (6 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**.

3.4 INSTALLATION OF MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses

and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [**running bond**][**bond pattern indicated on Drawings**] ; do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than [**2 inches (50 mm)**][**4 inches (100 mm)**] . Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout **24 inches (600 mm)** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Rigid, Cellular Thermal Insulation, CMUs: Install molded-polystyrene insulation units into masonry unit cells before laying units.

J. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of hollow CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide **1/2-inch (13-mm)** clearance between end of anchor rod and end of tube. Space anchors [**48 inches (1200 mm)**] o.c. unless otherwise indicated.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."
5. Joint Sealants: Comply with ASTM C1193 for use of joint sealants, including acoustic sealants as applicable to materials, applications and Project conditions.
6. Penetration Firestopping: Install penetration firestopping systems for Project applications to comply with manufacturer's written installation instructions.

3.5 INSTALLATION OF MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are

not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Where applicable, set masonry trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Wet joint surfaces thoroughly before applying mortar.
3. Rake out mortar joints for pointing with sealant.

D. Prefaced CMUs: Rake out mortar joints at units to a uniform depth of **1/4 inch (6 mm)** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

G. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 INSTALLATION OF MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of **5/8 inch (16 mm)** on exterior side of walls, **1/2 inch (13 mm)** elsewhere. Lap reinforcement a minimum of **6 inches (150 mm)**.

1. Space reinforcement not more than **16 inches (406 mm)** o.c.
2. Space reinforcement not more than **8 inches (203 mm)** o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than **8 inches (203 mm)** above and below wall openings and extending **12 inches (305 mm)** beyond openings [**in addition to continuous reinforcement**] .

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at [**corners,**] returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 INSTALLATION OF ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than [**1/2 inch (13 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than **24 inches (610 mm)** o.c. vertically and **36 inches (915 mm)** o.c. horizontally.

3.8 INSTALLATION OF CONTROL JOINTS

A. General: Install control joint materials in CMUs as masonry progresses. Do not allow materials to span control joints without provision to allow for in-plane wall or partition movement.

B. Locate control joints. [**See Drawings**][**Comply with CMU-TEC-009-25**] .

C. Form control joints in CMUs as follows:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.9 INSTALLATION OF LINTELS

A. Install lintels over openings as indicated.

B. Provide concrete or formed-in-place masonry lintels where shown and where openings of more than **12 inches (305 mm)** for brick-size units and **24 inches (610 mm)** for block-size units are shown without structural steel or other supporting lintels. Provide minimum bearing of **8 inches (200 mm)** at each jamb unless otherwise indicated.

C. Install loose steel over openings [**.**][**as follows:**][**See Drawings.**]

1. Provide minimum bearing of **8 inches (200 mm)** at each jamb unless otherwise indicated.

D. Lintels at Fire-Rated Openings: Provide fire-rated masonry required or steel lintels with applied fireproofing in thickness required to maintain fire rating of wall or partition rating.

3.10 INSTALLATION OF EMBEDDED FLASHING

A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape [**as recommended by flashing manufacturer**] .
2. At lintels, extend flashing a minimum of **6 inches (150 mm)** into masonry at each end. At heads and sills, extend flashing **6 inches (150 mm)** at ends and turn up not less than **2 inches (50 mm)** to form end dams.
3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than **1-1/2 inches**

(38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

4. Install metal [**drip edges**][**and**][**sealant stops**] with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.11 INSTALLATION OF REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 402/602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than [60 inches (1500 mm)][12.67 ft. (3.86 m)] .

3.12 INSTALLATION OF MASONRY-CELL FILL

A. Loose-Fill Insulation: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than 20 ft. (6 m).

B. Lightweight-Aggregate Fill: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than 20 ft. (6 m).

C. Foamed-In-Place Masonry Cell Fill: Drill holes in mortar bed joints at spacing as indicated in writing by foamed-in-place masonry fill manufacturer, and inject foam to fill masonry cell voids.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements is done at Contractor's expense.

B. Inspections: Special inspections in accordance with [**Level 2**][**Level 3**] in TMS 402/602.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces, grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each **5000 sq. ft. (464.5 sq. m)** of wall area or portion thereof.

E. Concrete Masonry Units: Test for each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Mortar Aggregates: Ratio test (Proportion Specification) for each mix provided, in accordance with ASTM C780.

G. Mortar: Test for each mix provided, in accordance with ASTM C780. Test mortar for [**mortar air content**][**and**][**compressive strength**] .

H. Grout: Test for each mix provided, in accordance with ASTM C1019.

I. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at [**7 days and at**] 28 days.

J. Fire-Resistance-Rated Construction: Where applicable, inspect fire-rated CMU construction to determine compliance with construction documents per building code compliance.

3.14 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of **3/4 inch (19 mm)**. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of **1/8 inch per ft. (3 mm per 300 mm)**. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.15 REPAIRING AND POINTING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

3.16 CLEANING

A. In-Progress Cleaning: Clean unit masonry as Work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry, as directed by the Owner.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid-strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in TEK 08-04A.

3.17 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than **4 inches (100 mm)** in each dimension.
2. Mix masonry waste with at least 2 parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within **18 inches (450 mm)** of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose as directed by the Owner.

END OF SECTION 04 22 00 00

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Task	Specification	Specification Description
04 22 00 00	04 20 00 00a	Masonry Veneer
04 22 23 00	04 22 00 00	Concrete Unit Masonry
04 22 23 00	04 20 00 00a	Masonry Veneer
04 22 23 13	04 20 00 00	Unit Masonry
04 22 23 13	04 22 00 00	Concrete Unit Masonry
04 22 23 13	04 20 00 00a	Masonry Veneer
04 22 23 23	04 20 00 00	Unit Masonry
04 22 23 23	04 22 00 00	Concrete Unit Masonry
04 22 23 23	04 20 00 00a	Masonry Veneer
04 22 23 26	04 20 00 00	Unit Masonry
04 22 23 26	04 22 00 00	Concrete Unit Masonry
04 22 23 26	04 20 00 00a	Masonry Veneer
04 22 23 29	04 20 00 00	Unit Masonry
04 22 23 29	04 22 00 00	Concrete Unit Masonry
04 22 23 29	04 20 00 00a	Masonry Veneer
04 22 23 31	04 20 00 00	Unit Masonry
04 22 23 31	04 22 00 00	Concrete Unit Masonry
04 22 23 31	04 20 00 00a	Masonry Veneer

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SECTION 04 23 00 00 - GLASS UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass block.
2. Mortar materials.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for [**steel frames**][**and**][**loose steel lintels**] at glass unit masonry assemblies.

1.2 SEQUENCING AND SCHEDULING

A. Sequence and coordinate completion of glass unit masonry assemblies so sealants can be installed immediately after mortar has attained final set.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Fabrication and installation details for [**glass unit masonry, including vertical and horizontal coursing, anchors, reinforcement, and expansion strips**][**and**][**glass-block panel systems**][**and**][**glass-block grid systems**]. Include accessories where indicated.

C. Samples for Initial Selection: [**Manufacturer's actual glass-block units**][**glass-block grid material**][**and**][**joint materials involving color selection**].

D. Samples for Verification:

1. [**Glass-block units**][**glass-block grid material**][**and**][**joint materials involving color selection**].
2. Panels consisting of four full-size glass-block units with [**glass-block grid**][**mortar**][**and**][**sealant**] joints.

a. Provide Samples for each form, pattern, and color of glass block and color of joint material indicated or selected by Architect, as directed by the Owner.

E. Delegated Design Submittals: For installed products, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Research Reports: For post-installed anchors, from ICC-ES.

B. Qualification Statements: For professional engineer.

1.5 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical [**exterior**][**and**][**interior**] panel, **48 by 48 inches (1200 by 1200 mm)** in size.
2. Build mockup of typical [**exterior wall area**][**and**][**interior partition**] containing glass unit masonry assembly as shown on Drawings.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store glass block in unopened cartons on elevated platforms, under cover, and in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store glass-block grid materials in unopened cartons in an enclosed, dry location.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

E. Store accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation of glass unit masonry assemblies only when ambient and material temperatures are **40 deg F (5 deg C)** or higher.

1. Maintain temperature in installation areas at **40 deg F (5 deg C)** or above for 48 hours after installing.
2. Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or when joint substrates are wet.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For glass block, obtain[**each type and pattern of**] glass block from single source from single

manufacturer.

B. For accessory materials, obtain each [**cementitious material**][**admixture**][**and**][**accessory component**] from single source from single manufacturer[**and each aggregate from single source or producer**].

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glass-block grid systems, including attachment to building construction.

B. Structural Performance: Glass-block grid systems, including attachment to building construction, to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Loads: As indicated on Drawings.

C. Glass-Block Panels - General:

1. Non-load bearing, isolated within opening glass fiber or white polyethylene foam expansion strips at jambs and head.
2. Head and Jamb Channels: Size and material as recommended by manufacturer for glass-block units selected. Provide bond breaker as recommended by manufacturer at sill where required by glass-block panel design.

2.3 FIRE-RATED GLASS UNIT MASONRY

A. Assemblies are listed by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 257.

2.4 GLASS BLOCK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Seves Glass Block, Inc.**]

B. Glass Unit Masonry: .

1. Sizes, General: Provide manufacturer's standard sizes unless indicated as custom.
2. Square Glass-Block Size: [**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**7-3/4 inches (197 mm)**][**12.99 inches (33 cm)**] square by [**3-1/8 inches (79 mm)**][**4.72 inches (12 cm)**] thick.
3. Other Glass-Block Size: [**13 inches (33 cm)**][**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**11-3/4 inches (299 mm)**] by [**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**11-3/4 inches (299 mm)**] by **3-1/8 inches (79 mm)** thick.
4. Glass Unit Masonry Patterns:

a. Pattern:

1) Smooth, undistorted inner and outer faces.

2) Wavy, light-diffusive design on inner faces, and smooth outer faces.
3) Fluted, light-diffusive design, horizontal on one inner face, vertical on other, and smooth outer faces.
4) Linear prismatic design, horizontal on one inner face, vertical on other, and smooth outer faces.
5) Prismatic pyramid, light-diffusive design on inner faces, and smooth outer faces.
6) As indicated by manufacturer's designation.
7) Manufacturer's standard decorative pattern to match Architect's sample, as directed by the Owner.
8) As selected by Architect from manufacturer's full range.

5. Glass Color: [**Colorless**][**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**].
6. Edge-Coating Color: [**White**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

a. Provide one color throughout for each pattern indicated.
b. Provide multiple colors as indicated for each size and pattern.

7. [**45**][**60**][**90**]-minute fire rating complying with NFPA 257.
8. High-Performance, Prefabricated, Panel Glass-Block System:

a. Hurricane Resistant: [**Complies with large missile impact test ASTM E1886 and ASTM 1996**][**Tested to Florida and Dade County approval protocols TAS 201, TAS 202, and TAS 203**][**Window Size and Design Pressure Rating: As recommended by manufacturer**].
b. Tornado Resistant: [**Complies with ASTM E330**][**Air pressure test as recommended by manufacturer**].
c. Blast Resistant: [**Complies with GSA and UFC 04-0110-01 blast glass standards**].
d. Security and Detention: [**ANSI Z97.1**][**16 CFR 1201**].

9. Performance Requirements:

a. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of [**0.30 Btu/sq. ft. x h x deg F (1.71 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.83 W/sq. m x K)**][**0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K)**][**0.60 Btu/sq. ft. x h x deg F (3.43 W/sq. m x K)**].
b. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of [**0.40**][**0.30**][**0.27**].
c. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
d. Sound Transmission Class (STC): Rated for not less than [**43**][**48**][**50**][**53**] STC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E413.

10. Special Shapes and Finishing Units: .

a. Corner-Block Sizes and Shapes: Manufacturer's standard units designed to form [**90**][**45**][**22.5**]-degree corners when joined with straight units of same height.
b. End-Block Size and Shape: [**7-1/2 inches (19 cm)**][**7-3/4 inches (95 by 197 mm)**] square by [**3-7/8 inches (98 mm)**][**3-1/8 inches (79 mm)**] thick.

c. Curved-Block Size and Shape: [7-1/2 inches (19 cm)] square by [3-7/8 inches (98 mm)][3-1/8 inches (79 mm)] thick.
d. Radius-Block Sizes and Shapes: End unit with top matching finished end and with rounded finished corner in manufacturer's standard size to match end units.

11. Graphic-Applied Glass Block: .

a. Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [6 inches (152 mm) **square by** 1 inch (25 mm)][4-3/4 inches (120 mm) **square by** 1-9/16 inches (40 mm)][6-5/16 inches (160 mm) **square by** 1-3/16 inches (30 mm)][7-1/2 inches (190 mm) **square by** 1-15/16 inches (50 mm)][7-1/2 inches (190 mm) **square by** 2-3/4 inches (70 mm)][7-7/8 inches (200 mm) **square by** 7/8 inch (22 mm)][7-7/8 inches (200 mm) **square by** 1-15/16 inches (50 mm)][4-5/8 inches (117 mm) **in diameter by** 2-3/8 inches (60 mm)] thick, actual size.

12. Solar Glass Block: .

a. Glass Block for Solar Wall Tubes: Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface.
b. Size: [8 inches (20 mm) **square**][8 by 16 inches (20 by 40 mm)].

2.5 GLASS-BLOCK PAVERS

A. Horizontal Block and Glass-Pavers: . Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [4.33 inches (11 cm) **square by** 2.36 inches (6 cm)][5.57 inches (14 cm) **square by** 1.96 inches (5 cm)][5.57 inches (14 cm) **square by** 4.33 inches (11 cm)][6.29 inches (16 cm) **square by** 1.18 inches (3 cm)][7.48 inches (19 cm) **square by** 2.75 inches (7 cm)][7.48 inches (19 cm) **square by** 3.15 inches (8 cm)][7.48 inches (19 cm) **square by** 3.93 inches (10 cm)][7.87 inches (20 cm) **square by** 0.78 inch (2 cm)].

B. Glass-Paver Round Blocks: . Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [4.33 inches (11 cm) **in diameter by** 2.36 inches (6 cm)][7.48 inches (19 cm) **in diameter by** 1.96 inches (5 cm)][7.48 inches (19 cm) **in diameter by** 3.93 inch (10 cm)] thick.

C. Horizontal Glass-Pavers, Fire-Resistant: . Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [7.48 inches (19 cm) **square by** 3.12 inches (8 cm)][7.48 inches (19 cm) **square by** 6.29 inches (16 cm)] thick.

1. [**45**][**60**][**90**]-minute fire rating complying with NFPA 257.

D. Horizontal Glass-Pavers, Historical Design: . Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [2.7 inches (7 cm) **square by** 1.88 inches (4.8 cm)][3.54 inches (9 cm) **square by** 0.74 inch (1.9 cm)][3.54 inches (9 cm) **square by** 0.98 inch (2.5 cm)] thick.

E. Horizontal Glass-Solar-Powered (Photovoltaic) Pavers: . Transparent, colorless, half-shell glass block, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface.

1. Round: 4.33 inches (11 cm) in diameter by 2.36 inches (6 cm) thick.
2. Square: 4.33 inches (11 cm) square by 2.36 inches (6 cm) thick.
3. Performance: Internal lithium battery (LiFePO4 3.2v) and high-luminosity LED diodes (3000-3500MCD).
4. Light Color: Cool white.

5. Service Life: 50,000 hours.

2.6 PREFABRICATED GLASS-BLOCK PANELS AND WINDOWS

A. Glass Unit Masonry: .

1. Sizes, General: Provide manufacturer's standard sizes unless indicated as custom.
2. Square Glass-Block Size: [**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**] square by **3-7/8 inches (98 mm)** thick.
3. Other Glass-Block Size: [**3-3/4 inches (95 mm)**][**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**11-3/4 inches (299 mm)**] by [**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**11-3/4 inches (299 mm)**] by **3-7/8 inches (98 mm)** thick.
4. Glass Unit Masonry Patterns:

    a. Pattern:

        1) Smooth, undistorted inner and outer faces.
        2) Wavy, light-diffusive design on inner faces, and smooth outer faces.
        3) Fluted, light-diffusive design, horizontal on one inner face, vertical on other, and smooth outer faces.
        4) Linear prismatic design, horizontal on one inner face, vertical on other, and smooth outer faces.
        5) Prismatic pyramid, light-diffusive design on inner faces, and smooth outer faces.
        6) As indicated by manufacturer's designation.
        7) Manufacturer's standard decorative pattern to match Architect's sample, as directed by the Owner.
        8) As selected by Architect from manufacturer's full range.

5. Glass Color: [**Color**][**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**].
6. Edge-Coating Color: [**Color**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

    a. Provide one color throughout for each pattern indicated.
    b. Provide multiple colors as indicated for each size and pattern.

B. Special Shapes and Finishing Units: .

1. Corner-Block Sizes and Shapes: Manufacturer's standard units designed to form [**90**][**45**][**22.5**]-degree corners when joined with straight units of same height.
2. End-Block Size and Shape: [**7-1/2 inches (19 cm)**][**7-3/4 inches (95 by 197 mm)**] square by [**3-7/8 inches (98 mm)**][**3-1/8 inches (79 mm)**] thick.
3. Curved-Block Size and Shape: [**7-1/2 inches (19 cm)**] square by [**3-7/8 inches (98 mm)**][**3-1/8 inches (79 mm)**] thick.
4. Radius-Block Sizes and Shapes: End unit with top matching finished end and with rounded finished corner in manufacturer's standard size to match end units.
5. Glass-Block Window Vents:

    a. Vinyl sash windows.
    b. Vinyl air vents.
    c. Vinyl dryer vents.

2.7 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II. Provide natural color or white cement as required to produce mortar color indicated.

1. Where joints are indicated to be raked out and pointed, gray cement may be used for setting mortar.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cemex S.A.B. de C.V.**]
b. [**Heidelberg Materials**]
c. [**Holcim (US) Inc**]

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Davis Colors**]
b. [**Lanxess Corporation**]
c. [**Solomon Colors Inc.**]

F. Colored Cement Product: Packaged blend made from [**portland cement and hydrated lime**][**or**][**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Heidelberg Materials**]
2) [**Holcim (US) Inc**]

2. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Cemex S.A.B. de C.V.**]
2) [**Heidelberg Materials**]
3) [**Holcim (US) Inc**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of masonry cement by weight.

G. Aggregate: ASTM C144, with 100 percent passing **No. 8 (2.36-mm)** sieve.

1. For [**pointing mortar**][**and**][**joints narrower than 1/4 inch (6 mm)**], use aggregate graded with 100 percent passing **No. 16 (1.18-mm)** sieve.
2. White Aggregates: Natural white sand or crushed white stone.
3. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

H. Dry Water-Repellent Admixture: Dry mixture of stearates, water-reducing agents, and fine aggregates intended to reduce capillarity in mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACM Chemistries**]
b. [**GCP Applied Technologies Inc.**]
c. [**Master Builders Solutions**]

I. Liquid Water-Repellent Admixture: Liquid polymeric water-repellent mortar admixture that does not reduce flexural bond strength of mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACM Chemistries**]
b. [**GCP Applied Technologies Inc.**]
c. [**Master Builders Solutions**]

J. Water: Potable.

2.8 GLASS UNIT MASONRY ACCESSORIES

A. Aluminum Perimeter Channels: Two-piece aluminum channel.

1. Sizes: As recommended by manufacturer.
2. Finish: [**Mill**][**Anodized clear**][**Anodized bronze**][**Powder coating**].

B. Mortarless Glass-Block Grid System: Custom glass-block grid system for windows and walls.

1. Finish: As selected from manufacturer's standard finishes and colors.

C. Panel Reinforcement: Ladder-type units, butt welded, not lapped and welded; complying with ASTM A951/A951M in straight lengths of not less than **10 ft. (3 m)**, and as follows:

1. Interior Walls: Hot-dip galvanized, carbon steel wire.
2. Exterior Walls: [**Hot-dip galvanized, carbon**][**Stainless**] steel wire.
3. Wire Size: W1.7 or **0.148-inch (3.8-mm)** diameter.
4. Width: [**2 inches (50 mm)**][**1-5/8 inches (40 mm)**].
5. Spacing of Cross Rods: Not more than **16 inches (407 mm)** apart.

D. Panel Anchors: Glass-block manufacturer's standard perforated steel strips, **0.0359 inch (0.9 mm)** by **1-3/4 inches (44 mm)** wide by **24 inches (600 mm)** long, hot-dip galvanized after fabrication to comply with ASTM A153/A153M.

E. Mortarless Installation System: System of [**aluminum**][**or**][**plastic**] perimeter framing, anchors, and spacers designed for installing glass block with sealant-filled joints.

F. Fasteners, General: Unless otherwise indicated, provide Type 304 or Type 316 stainless steel fasteners at exterior walls and zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, at interior walls. Select fasteners for type, grade, and class required.

G. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

H. Asphalt Emulsion: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M or ASTM D1227/D1227M.

I. Mineral-Fiber Expansion Strips: Comply with requirements of fire-rated assembly listing and glass-block manufacturer.

1. Use for fire-rated assemblies.

J. Plastic-Foam Expansion Strips: Polyethylene foam complying with requirements of glass-block manufacturer; **3/8 inch (9 mm)** thick by [**4 inches (100 mm)**][**3-1/2 inches (89 mm)**][**2-1/2 inches (63 mm)**] wide.

1. Use plastic-foam expansion strips for[**fire-rated and**] non-fire-rated assemblies.

K. Sealants: Manufacturer's standard elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Section 079200 "Joint Sealants."

1. Silicone: Nonstaining, S, NS, 50, NT .
2. Urethane: S, NS, 25, NT .
3. Sealant shall have a VOC content of 250 g/L or less.
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

L. Sealant Accessories: Provide sealant accessories, including primers, bond-breaker tape, and cylindrical sealant backing, that comply with applicable requirements in Section 079200 "Joint Sealants."

2.9 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, or antifreeze compounds unless otherwise indicated.

1. Do not use calcium chloride in mortar.
2. For mortar in exterior panels, use water-repellent admixture in accordance with admixture manufacturer's written instructions.
3. For pointing mortar in exterior panels, use water-repellent admixture in accordance with admixture manufacturer's written instructions.
4. Limit cementitious materials in mortar to portland cement and lime.

B. Mortar for Glass Unit Masonry Assemblies:

1. Provide mortar, mixed in accordance with glass-block manufacturer's listing with testing and inspecting agency, for fire-resistance rating indicated.
2. Comply with ASTM C270, Proportion Specification for Type S mortar.

a. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer unless otherwise indicated. Mix mortar to produce a stiff but workable consistency that is drier than mortar for brick or concrete masonry. Discard mortar when it has reached initial set.

C. Pigmented Mortar: Use colored cement product[**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products**].

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of masonry cement by weight.
3. Mix to match Architect's sample, as directed by the Owner.

D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample, as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine sills, jambs, and heads surrounding glass unit masonry assemblies, with Installer present, for

compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF GLASS BLOCK WITH MORTAR

A. General: Install masonry units in accordance with manufacturer's written instructions.

1. Where applicable, fasten frames and anchors or clips securely to surrounding construction.
2. Shim starting track as needed to make it level.
3. Arrange coursing pattern to provide consistent joint work throughout.

B. Apply a heavy coat of asphalt emulsion to sill and adhere expansion strips to jambs and heads with asphalt emulsion. Allow asphalt emulsion to dry before placing mortar. Trim expansion strips to width required to fit glass block and to full lengths of heads and jambs.

C. Set glass block with completely filled bed and head joints, with no furrowing, accurately spaced and coordinated with other construction. Maintain [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] exposed joint widths unless otherwise indicated.

D. Install panel reinforcement in horizontal joints at spacing indicated and continuously from end to end of panels; comply with the following requirements:

1. Vertical Spacing of Panel Reinforcement for Exterior Panels: [**Every other course, but not more than 16 inches (407 mm) o.c., starting with first course above sill**][**As indicated on Drawings**].
2. Vertical Spacing of Panel Reinforcement for Interior Panels: [**Not more than 16 inches (407 mm) o.c.**][**As indicated on Drawings**].
3. Do not bridge expansion joints with panel reinforcement.
4. Place panel reinforcement in joints immediately above and below all openings within glass unit masonry assemblies.
5. Lap panel reinforcement not less than **6 inches (150 mm)** if more than one length is necessary.
6. Embed panel reinforcement in mortar bed by placing lower half of mortar bed first, pressing panel reinforcement into place, and covering with upper half of mortar bed.

E. Install panel anchors at locations indicated and in same horizontal joints where panel reinforcement occurs. Extend panel anchors at least **12 inches (300 mm)** into joints, and bend within expansion joints at edges of panels and across the head. Attach panel anchors as follows:

1. For in-place unit masonry assemblies and concrete, attach panel anchors with **1/4-inch- (6-mm-)** diameter, bolt-size post-installed anchors, two per panel anchor.
2. For new unit masonry assemblies, embed other ends of panel anchors, after bending portions crossing expansion joint, in horizontal mortar joints closest in elevation to joints in glass unit masonry assemblies containing panel anchors.
3. For steel members, attach panel anchors with **1/4-inch- (6-mm-)** diameter through bolts and nuts or bolts in tapped holes in steel members.

F. Use rubber mallet to tap units into position. Do not use steel tools, and do not allow units to come into contact with metal accessories and frames.

G. Use [**plastic spacers**][**or**][**temporary wedges**] in mortar joints to produce uniform joint widths and to prevent mortar from being squeezed out of joints.

1. If temporary wedges are used, remove them after mortar has set and fill voids with mortar.

H. Keep expansion joints free of mortar.

I. Rake out joints indicated to be pointed to a uniform depth sufficient to accommodate pointing material, but not less than joint width.

1. If temporary wedges are used, remove them before raking out and pointing joints.
2. Point joints at [**exterior face**][**both faces**] of exterior panels with mortar.
3. Point joints at [**exterior face**][**both faces**] of exterior panels with sealant.
4. Point joints at both faces of exterior and interior panels with sealant.

J. Point joints with mortar by filling raked joints and voids. Place and compact pointing mortar in layers not more than **3/8 inch (10 mm)** thick. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

1. Tool exposed joints slightly concave when pointing mortar is thumbprint hard. Use a smooth plastic jointer larger than joint width.

K. Point joints by filling with sealant to comply with requirements in Section 079200 "Joint Sealants."

L. Clean glass unit masonry assemblies as work progresses. Remove mortar fins and smears immediately, using a clean, wet sponge or a scrub brush with stiff fiber bristles. Do not use harsh cleaners, acids, abrasives, steel wool, or wire brushes when removing mortar or cleaning glass unit masonry assemblies.

M. Install sealant at jambs, heads, mullions, and other locations indicated. Prepare joints, including installation of primer and bond-breaker tape or cylindrical sealant backing, and apply elastomeric sealants to comply with requirements in Section 079200 "Joint Sealants."

N. Construction Tolerances: Set glass block to comply with the following tolerances:

1. Variation from Plumb: For vertical lines and surfaces, do not exceed [**1/4 inch in 10 ft. (6 mm in 3 m)**, **3/8 inch in 20 ft. (9 mm in 6 m)**, **or 1/2 inch in 40 ft. (12 mm in 12 m)**][**1/8 inch in 10 ft. (3 mm in 3 m)**, **1/4 inch in 20 ft. (6 mm in 6 m)**, **or 3/8 inch in 40 ft. (9 mm in 12 m)**] or more.
2. Variation from Level: For bed joints and other conspicuous lines, do not exceed **1/8 inch in 10 ft. (3 mm in 3 m)**, **1/4 inch in 20 ft. (6 mm in 6 m)**, or **1/2 inch in 40 ft. (12 mm in 12 m)** or more.
3. Variation of Location in Plan: For location of elements in plan, do not vary from that indicated by more than plus or minus **1/4 inch (6 mm)**.
4. Variation in Mortar-Joint Thickness: Do not vary from joint thickness indicated by more than plus or minus **1/16 inch (1.5 mm)**.
5. For faces of adjacent exposed units, do not vary from flush alignment by more than **1/16 inch (1.5 mm)**.

3.3 INSTALLATION OF GLASS BLOCK WITH SEALANT

A. General: Install mortarless glass-block systems in accordance with manufacturer's written instructions.

1. Fasten frames and anchors or clips securely to surrounding construction.
2. Shim starting track as needed to make it level.
3. Adhere glass block to starting track and spacers with silicone sealant.

B. After glass blocks are installed, apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.

3.4 CLEANING

A. On surfaces adjacent to glass unit masonry assemblies, remove mortar, sealants, and other residue resulting from glass-block installation, in a manner approved by manufacturers of materials involved.

B. Remove excess sealants with commercial solvents in accordance with sealant manufacturer's written instructions. Exercise care not to damage sealant in joints.

C. Perform final cleaning of glass unit masonry assemblies when surface is not exposed to direct sunlight. Start at top of panel using generous amounts of clean water. Remove water with clean, dry, soft cloths; change cloths frequently[**to eliminate dried mortar particles and aggregate**].

END OF SECTION 04 23 00 00

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Task	Specification	Specification Description
04 23 00 00	04 20 00 00a	Masonry Veneer
04 23 13 00	04 20 00 00	Unit Masonry
04 23 13 00	04 23 00 00	Glass Unit Masonry
04 23 13 00	04 20 00 00a	Masonry Veneer
04 41 00 00	04 42 00 00	Exterior Stone Cladding

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SECTION 04 42 00 00 - EXTERIOR STONE CLADDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stone panels set with individual anchors.
2. Stone panels mechanically anchored on steel trusses.
3. Stone panels mechanically anchored on steel strongback frames.
4. Stone panels mechanically anchored on steel stud frames.
5. Stone panels mechanically anchored (field installed) on a metal-grid system.
6. Stone panels set in architectural precast concrete.
7. Stone panels glazed into aluminum curtain-wall framing system.
8. Stone trim units, including [**bands**][**copings**][**sills**][**jambs**][**and**][**soffits**].
9. Stone units with carving or inscriptions.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for installing [**inserts**][**and**][**weld plates**] in concrete for anchoring stone cladding.
2. Section 034500 "Precast Architectural Concrete" for casting stone panels in architectural precast concrete units.
3. Section 042000 "Unit Masonry" [**for installing inserts in unit masonry for anchoring stone cladding**][**and**][**for stone trim in unit masonry walls**].
4. Section 054000 "Cold-Formed Metal Framing" for steel stud frames supporting stone cladding.
5. Section 079200 "Joint Sealants" for sealing joints in stone cladding system with elastomeric sealants.
6. Section 084413 "Glazed Aluminum Curtain Walls" for installing stone panels in aluminum curtain-wall systems.
7. Section 096340 "Stone Flooring" for dimension stone used as paving and flooring.
8. Section 097513 "Stone Wall Facing" for dimension stone applied as paneling on building interiors.

1.2 DEFINITIONS

A. Definitions contained in ASTM C119 apply to this Section.

B. IBC: International Building Code.

C. Stone Cladding Assembly: An exterior wall covering system consisting of stone panels[**and trim**] together with anchors, [**backup structure,**][**secondary weather barrier (sheathing),**][**mortar,**][**adhesives,**] fasteners, and sealants used to secure the stone to the building structure and to produce a weather-resistant covering.

1. Backup structure includes [**steel trusses**][**steel strongback frames**][**steel stud frames**][**metal-grid system**][**and**][**miscellaneous steel framing required to secure stone to the building structure**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each[**variety of stone,**] stone accessory, and manufactured product.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Show fabrication and installation details for stone cladding assembly, including dimensions and profiles of stone units.

1. Show locations and details of joints both within stone cladding assembly and between stone cladding assembly and other construction.
2. Include details of [**mortar joints**][**sealant joints**][**and**][**mortar joints pointed with sealant**].
3. Show locations and details of anchors[**and backup structure**].
4. Show direction of veining, grain, or other directional pattern.
5. Include large-scale shaded elevations and details of decorative surfaces and inscriptions.

D. Samples for Initial Selection: For joint materials involving color selection.

E. Stone Samples for Verification: Sets for each variety, color, and finish of stone required; not less than **12 inches (300 mm)** square.

1. Sets consist of at least [**two**][**three**][**four**][**five**] Samples, exhibiting extremes of the full range of color and other visual characteristics expected and will establish the standard by which stone will be judged.

F. Colored Pointing Mortar Samples for Verification: For each color required. Make Samples using same sand and mortar ingredients to be used on Project.

G. Sealant Samples for Verification: For each type and color of joint sealant required.

H. Delegated Design Submittal: For stone cladding assembly.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**fabricator**][**professional engineer**][**and**][**testing agency**].

B. Welding certificates.

C. Material Test Reports:

1. Stone Test Reports: For[**each**] stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous [**five**][**three**] years.
2. For metal components, by a qualified testing agency, indicating chemical and physical properties of metal.
3. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer complying with requirements in Section 079200 "Joint Sealants" and indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

D. Preconstruction test reports.

E. Source quality-control reports.

F. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate stone cladding assemblies similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: A firm or individual experienced in installing stone cladding assemblies similar in material, design, and extent to that indicated for this Project, whose work has a record of successful in-service performance.

C. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

D. Welding Qualifications: Qualify procedures and personnel according to [**AWS D1.1/D1.1M, "Structural Welding Code - Steel**][**AWS D1.2/D1.2M, "Structural Welding Code - Aluminum**][**AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel**][**and**][**AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel**]."

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of typical exterior wall area [**as shown on Drawings**][**not less than 72 inches (1800 mm) long by 48 inches (1200 mm) high**][**not less than 15 feet (4.5 m) long by 10 feet**

(3 m) high].

a. Include typical components, attachments to building structure, and methods of installation.
b. Include window opening with stone [**returns**][**trim**].
c. Include typical carved surface.
d. Include sealant-filled joint complying with requirements in Section 079200 "Joint Sealants."
e. Include an area that has been damaged and repaired.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Stone Testing Service: [**The Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing.

1. Retesting of materials that fail to meet specified requirements is done at Contractor's expense.
2. Furnish test specimens that are representative of materials proposed for incorporation into the Work.
3. Physical Property Tests: For[**each**] stone variety proposed for use on Project, tested for compliance with physical property requirements, other than abrasion resistance, according to referenced ASTM standards.
4. Flexural Strength Tests: For[**each combination of**] stone variety, thickness, orientation of cut, and finish, proposed for use on Project, tested according to ASTM C880/C880M, in both wet and dry conditions.
5. Anchorage Tests: For[**each combination of**] stone variety, orientation of cut, finish, and anchor type proposed for use on Project, tested according to ASTM C1354/C1354M.
6. Anchoring System Mockup Test: For stone anchoring system, tested according to ASTM C1201/C1201M, Procedure B, with a maximum test load equal to 3 times the design load. Build laboratory mockup at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site. Mockup consists of one panel in size.

B. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 079200 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

C. Preconstruction Field Testing of Sealants: Before installing joint sealants, field test their adhesion to joint substrates according to Section 079200 "Joint Sealants."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

B. Mark stone units, on surface that will be concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels so that they are right side up when units are installed.

C. Deliver sealants to Project site in original unopened containers labeled with manufacturer's name, product name and designation, color, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.

D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

E. Store aggregates in locations where grading and other required characteristics can be maintained and where contamination can be avoided.

1.10 FIELD CONDITIONS

A. Protect stone cladding during erection by doing the following:

1. Cover tops of stone cladding installation with nonstaining, waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of **24 inches (600 mm)** down both sides and hold securely in place.
2. Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials without damaging stone.
3. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.
4. Protect sills, ledges, and projections from mortar and sealant droppings.

B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Remove and replace stone cladding damaged by frost or freezing conditions. Comply with cold-weather construction and protection requirements for masonry contained in TMS 602/ACI 530.1/ASCE 6.

C. Hot-Weather Requirements: Comply with hot-weather construction and protection requirements for masonry contained in TMS 602/ACI 530.1/ASCE 6.

D. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below **40 deg F (5 deg C)** or when joint substrates are wet.

1.11 COORDINATION

A. Coordinate installation of inserts that are to be embedded in concrete or masonry, flashing reglets, and similar items to be used by stone cladding Installer for anchoring, supporting, and flashing of stone cladding assembly. Furnish setting drawings, templates, and directions for installing such items and deliver to Project site in time for installation.

B. Time delivery and installation of stone cladding to avoid extended on-site storage and to coordinate with work adjacent to stone cladding.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Stone: Obtain[**each variety of**] stone[**regardless of finish,**] from single quarry[**whether specified in this Section or in another Section of the Specifications,**] with resources to provide materials of consistent quality in appearance and physical properties.

1. For stone types that include same list of varieties and sources, provide same variety from same source for each.
2. Make quarried blocks available for examination by Architect or as directed by the Owner.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.

C. Source Limitations for Other Materials: Obtain each type of stone accessory[**sealant,**] and other material from single manufacturer for each product.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stone cladding assembly.

B. General: Design stone anchors and anchoring systems according to ASTM C1242.

1. Stone anchors withstand not less than two times the weight of the stone cladding in both compression and tension.

C. Structural Performance: Stone cladding assembly withstands the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Wind Loads: As indicated.
2. Equipment Loads: Allow for loads due to window cleaning and maintenance equipment.

D. Seismic Performance: Stone cladding assembly withstands the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: [**1.5**][**1.0**].

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.

F. Horizontal Building Movement (Interstory Drift): Allow for maximum horizontal building movement equal to quotient resulting from dividing floor-to-floor height at any floor by 400.

G. Shrinkage and Creep: Allow for progressive vertical shortening of building frame equal to in **10 feet (3 m)**.

H. Safety Factors for Stone: Design stone cladding assembly to withstand loads indicated without exceeding stone's allowable working stress determined by dividing stone's average ultimate strength, as established by testing, by the following safety factors:

1. Safety Factor for Granite: [**3**].
2. Safety Factor for Oolitic Limestone: [**8**].
3. Safety Factor for Dolomitic Limestone: [**6**].
4. Safety Factor for Marble: [**5**].
5. Safety Factor for Quartz-Based Stone: [**6**].
6. Safety Factor for Serpentine: [**6**].
7. Safety Factor for Slate: [**5**].
8. Safety Factor for Travertine: [**8**].

9. Safety Factor for Concentrated Stresses: [**4**][**for granite**][**and**][**10**][**for stone varieties other than granite**].

I. Design stone anchors[**and backup structure**] to withstand loads indicated without exceeding allowable working stresses established by the following:

1. For Structural Steel: AISC 360.
2. For Cold-Formed Steel: AISI's "North American Specification and Commentary for the Design of Cold-Formed Steel Structural Members."
3. For Cold-Formed Stainless Steel: ASCE/SEI 8, "Specification for the Design of Cold-Formed Stainless Steel Structural Members."
4. For Aluminum: AA ADM-1, "The Aluminum Design Manual."
5. For Cast-in-Place and Postinstalled Fasteners in Concrete: One-fourth of tested capacity when installed in concrete with compressive strength indicated.
6. For Postinstalled Fasteners in Masonry: One-sixth of tested capacity when installed in masonry units indicated.

J. Limit deflection in each prefabricated assembly caused by indicated loads and thermal movements, acting singly or in combination with one another, to not more than [**1/720**] of assembly's clear span or the following, whichever is smaller:

1. **1/16 inch (1.5 mm)**, measured in plane of wall.
2. **1/4 inch (6 mm)**, measured perpendicular to wall.

K. Provisions for Fabrication and Erection Tolerances: Allow for fabrication and erection tolerances of building's structural system. [**Concrete fabrication and erection tolerances are specified in Section 033000 "Cast-in-Place Concrete."**][**Structural-steel fabrication and erection tolerances are specified in Section 051200 "Structural Steel Framing."**]

L. Provision for Deflection of Building Structure:

1. Deflection Due to Weight of Stone Cladding Assembly: Allow for [**1/4-inch (6-mm)**] vertical deflection in **20-foot (6-m)** span of structural members supporting stone cladding assembly.
2. Live Load Deflection: Allow for [**1/4-inch (6-mm)**] vertical deflection, in **20-foot (6-m)** span of structural members supporting stone cladding assembly, due to live loads imposed on building's structural frame after stone installation.

M. Corrosion and Staining Control: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Materials do not stain exposed surfaces of stone and joint materials.

2.3 GRANITE

A. Material Standard: Comply with ASTM C615/C615M.

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials

are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Description: Uniform, [**fine**][**medium**]-grained, [**white**][**pink**][**gray**][**black**] stone[**without veining**].

H. Cut: [**Vein**][**Fleuri**].

1. Orientation of Veining: [**Horizontal**][**Vertical**][**As indicated**].

I. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

J. Finish: [**Polished**][**Honed**][**Thermal**][**As indicated**][**Match Architect's sample**].

K. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

L. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.

2.4 LIMESTONE

A. Material Standard: Comply with ASTM C568/C568M.

1. Classification: [**I Low-Density**][**II Medium-Density**][**II Medium-Density except as follows: absorption, 5 percent by weight maximum; density, 150 lb/cu. ft. (2400 kg/cu. m) minimum; compressive strength, 8000 psi (55 MPa) minimum; and modulus of rupture 800 psi (5.5 MPa) minimum**][**III High-Density**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Description: [**Dolomitic**][**Oolitic**][**Shell**] limestone.

H. Varieties and Sources: Indiana limestone quarried in Lawrence, Monroe, or Owen Counties, Indiana.

1. Indiana Limestone Grade and Color: [**Select, buff**][**Select, gray**][**Standard, buff**][**Standard, gray**][**Rustic, buff**][**Rustic, gray**][**Variegated**], according to grade and color classification established by ILI.

I. Cut: [**Vein**][**Fleuri**].

1. Orientation of Veining: [**Horizontal**][**Vertical**][**As indicated**].

J. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

K. Finish: [**Smooth finish**][**Sand rubbed**][**Machine tooled, four bats per 1 inch (25 mm)**][**Machine tooled, six bats per 1 inch (25 mm)**][**Machine tooled, eight bats per 1 inch (25 mm)**][**As indicated**][**Match Architect's sample**][**matching standard ILI finish**].

L. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

M. Thickness: Not less than [**1-1/4 inches (32 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] unless otherwise indicated.

2.5 MARBLE

A. Material Standard: Comply with ASTM C503/C503M, [**Classification I Calcite**][**Classification II Dolomite**][**Group A**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Description: Uniform, fine- to medium-grained, [**white**] stone with only slight veining.

H. Cut: [**Vein**][**Fleuri**].

1. Orientation of Veining: [**Horizontal**][**Vertical**][**As indicated**].

I. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

J. Finish: [**Polished**][**Honed**][**As indicated**][**Match Architect's sample**].

K. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

L. Thickness: Not less than [**1 inch (25 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.

2.6 QUARTZ-BASED STONE

A. Material Standard: Comply with ASTM C616/C616M, [**Classification I Sandstone**][**Classification II Quartzitic Sandstone**][**Classification III Quartzite**][**except for minimum free silica content**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Finish: [**Sand rubbed**][**Natural cleft**][**Thermal**][**As indicated**][**Match Architect's sample**].

H. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

I. Thickness: Not less than [**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] unless otherwise indicated.

2.7 SERPENTINE

A. Material Standard: Comply with ASTM C1526, [**Classification I Exterior**][**Classification II Interior**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to

determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

H. Finish: [**Polished**][**Honed**][**As indicated**][**Match Architect's sample**].

I. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

J. Thickness: Not less than [**1 inch (25 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.

2.8 SLATE

A. Material Standard: Comply with ASTM C629/C629M, [**Classification I Exterior**][**Classification II Interior**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Description: [**Black**][**Blue-black**][**Gray**][**Blue-gray**][**Green**][**Purple**][**Mottled purple and green**][**Red**] slate with a fine, even grain[**and unfading color,**] from clear, sound stock.

H. Finish: [**Honed**][**Sand rubbed**][**Natural cleft**][**As indicated**][**Match Architect's sample**].

I. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

J. Thickness: Not less than [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**] unless otherwise indicated.

2.9 TRAVERTINE

A. Material Standard: Comply with ASTM C1527/C1527M, [**Classification I Exterior**][**Classification II Interior**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Cut: [**Vein**][**Fleuri**].

1. Orientation of Veining: [**Horizontal**][**Vertical**][**As indicated**].

H. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

I. Filling: Fill pores on faces of stone with cementitious filler of color [**selected by Architect**][**matching Architect's sample**].

J. Finish: [**Polished**][**Honed**][**As indicated**][**Match Architect's sample**].

K. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

L. Thickness: Not less than [**1 inch (25 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.

2.10 OTHER STONE

A. Material Standards:

1. Maximum Absorption per ASTM C97/C97M.
2. Minimum Compressive Strength per ASTM C170/C170M.
3. Minimum Flexural Strength per ASTM C880/C880M.

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Finish: [**Polished**][**Honed**][**Sand rubbed**][**Natural cleft**][**As indicated**][**Match Architect's sample**].

H. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

I. Thickness: Not less than [**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] unless otherwise indicated.

2.11 FRAMING FOR BACKUP STRUCTURE

A. [**Steel Trusses**][**Strongback Frames**][**and**][**Miscellaneous Steel Framing**]: For framing members in contact with stone, fabricate from same material and finish specified for anchors. For framing members not in contact with stone, comply with requirements indicated below:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M or ASTM A992/A992M, minimum thickness of **3/16 inch (5 mm)**.
2. Steel Tubing: ASTM A500/A500M or ASTM A513/A513M, minimum thickness of **3/16 inch (5 mm)**.
3. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-4, made from [**galvanized steel complying with ASTM A653/A653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating, and not less than 0.108-inch (2.74-mm) nominal thickness**][**steel sheet complying with ASTM A1008/A1008M, structural steel, Grade 33 (Grade 230), not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A123/A123M**].

B. Steel Stud Frames: Galvanized-steel wall framing complying with Section 054000 "Cold-Formed Metal Framing."

1. Secondary Weather Barrier (Sheathing): Galvanized-steel sheet complying with ASTM A653/A653M, commercial steel, coating designation **G90 (Z275)**.

C. Metal-Grid Systems: Manufacturer's standard integrated system that combines metal struts, fittings, fasteners, and stone anchors and is engineered expressly for mechanically installing stone cladding.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Canaren Inc**]
b. [**Hohmann & Barnard, Inc**]
c. [**Meadow Burke**]

2. Struts: Cold-formed metal channels with continuous slot complying with MFMA-4, of size and shape required for application indicated, made from [**galvanized steel complying with ASTM A653/A653M, with G90 (Z275) coating, and not less than 0.108-inch (2.74-mm) nominal thickness**][**steel sheet complying with ASTM A1008/A1008M, not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A123/A123M**].
3. Fittings and Fasteners: System manufacturer's standard components of design, size, and material required to securely attach struts to building structure, by method indicated or selected, and stone anchors to struts, as well as to prevent galvanic corrosion. Fabricate components in contact with stone from same material specified for anchors.
4. Stone Anchors: Shapes and sizes standard with system manufacturer, complying with "Anchors and Fasteners" Article.

2.12 ANCHORS AND FASTENERS

A. Fabricate anchors[**including shelf angles,**] from stainless steel, ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**]; temper as required to support loads imposed without exceeding allowable design stresses. Fabricate dowels and pins for anchors from stainless steel, ASTM A276, [**Type 304**][**Type 316**].

B. Fabricate shelf angles for limestone from hot-dip galvanized steel, ASTM A36/A36M for materials and ASTM A123/A123M for galvanizing.

C. Fabricate anchors, including shelf angles, from extruded aluminum, **ASTM B221 (ASTM B221M)**, alloy and temper as required to support loads imposed without exceeding allowable design stresses, but not less than strength and durability properties of Alloy 6063-T6.

D. Cast-in-Place Concrete Inserts: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel, with capability to sustain, without failure, a load equal to 4 times the loads imposed as determined by testing per ASTM E488/E488M, conducted by a qualified independent testing agency. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329.

E. Postinstalled Anchor Bolts for Concrete and Masonry: [**Chemical anchors**][**torque-controlled expansion anchors**][**or**][**undercut anchors**] made from stainless steel components complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Alloy Group A1 or A4)** for bolts and nuts; ASTM A240/A240M, ASTM A276, or ASTM A666, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E488/E488M, conducted by a qualified independent testing agency.

F. Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers.

1. For [**stainless steel**][**and**][**aluminum**], use annealed stainless steel bolts, nuts, and washers; for bolts, **ASTM F593 (ASTM F738M)**; and for nuts, **ASTM F594 (ASTM F836M)**, Alloy [**Group 1 (A1)**][**Group 2 (A4)**].
2. For [**galvanized-steel shelf angles**][**and**][**backup structure**], use carbon-steel bolts, nuts, and washers; for bolts, **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; for nuts, **ASTM A563 (ASTM A563M)**, Grade A; and for washers, **ASTM F436 (ASTM F436M)**; all hot-dip or mechanically zinc coated.

G. Weld Plates for Installation in Concrete: Comply with Section 055000 "Metal Fabrications."

2.13 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction, natural color or white as required to produce mortar color indicated.

1. Low-Alkali Cement: Portland cement for use with limestone contains no more than 0.60 percent total alkali when tested according to ASTM C114.

B. Hydrated Lime: ASTM C207.

C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Pigments have a record of satisfactory performance in mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Davis Colors**]
b. [**Lanxess Corporation**]
c. [**Solomon Colors Inc.**]

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime.

E. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix produces color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments do not exceed 10 percent of portland cement by weight.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Heidelberg Materials**]
b. [**Holcim (US) Inc**]
c. [**Lafarge North America Inc.**]

F. Aggregate: ASTM C144; except for [**joints narrower than 1/4 inch (6 mm)**][**and**][**pointing mortar**], 100 percent pass **No. 16 (1.18-mm)** sieve.

1. White Aggregates: Natural white sand or ground white stone.
2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.

G. Water: Potable.

2.14 STONE ACCESSORIES

A. Setting Shims: Strips of [**resilient plastic**][**or**][**vulcanized neoprene, Type A Shore durometer hardness of 50 to 70**], nonstaining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.

B. Setting Buttons: Resilient plastic buttons, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone units without intruding into required depths of pointing materials.

C. Concealed Sheet Metal Flashing: Fabricated from[**zinc-tin, alloy-coated**] stainless steel in thicknesses indicated, but not less than **0.0156 inch (0.4 mm)** thick, and complying with Section 076200 "Sheet Metal Flashing and Trim."

D. Cementitious Dampproofing[**for Limestone**]: Cementitious formulation recommended by ILI and nonstaining to stone; compatible with joint sealants and noncorrosive to anchors and attachments.

E. Weep and Vent Tubes: [**Medium-density polyethylene tubing, 1/4-inch (6-mm) OD**][**Rectangular, cellular, polypropylene or clear butyrate extrusion, 3/8 by 1-1/2 inches (9 by 38 mm)**], of length required to extend from exterior face of stone to cavity behind.

F. Cellular Plastic Weep Hole/Vents: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, of length required to extend from exterior face of stone to cavity behind, in color selected from manufacturer's standard.

G. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, of length required to extend from exterior face of stone to cavity behind, in color selected from manufacturer's standard.

H. Wicking Material: Absorbent rope, made from [**cotton**][**or**][**UV-resistant synthetic fiber**], **1/4 to 3/8 inch (6 to 10 mm)** in diameter, of length required to produce **2-inch (50-mm)** exposure on exterior and **18 inches (450 mm)** in cavity between wythes.

I. Sealants for Joints in Stone Cladding: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Section 079200 "Joint Sealants" and do not stain stone:

1. Silicone: Nonstaining, [**S, NS, 100/50, NT**][**S, NS, 50, NT**][**S, NS, 100/50, T, NT**][**M, NS, 50, NT**].
2. Urethane: [**S, NS, 25, NT**][**S, NS, 100/50, T, NT**][**M, NS, 50, NT**][**M, NS, 50, T, NT**][**M, NS, 25, T, NT**].
3. Joint-Sealant Colors: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range of colors**][**Match color of stone**].

J. Preformed Joint Seals: Preformed [**silicone**][**foam**] joint seals that comply with applicable requirements in Section 079100 "Preformed Joint Seals" and do not stain stone.

K. Sealant for Filling Kerfs: [**Same sealant used for joints in stone cladding.**][**Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Section 079200 "Joint Sealants" and that do not stain stone:**]

1. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Adfast**]
      2) [**GE Construction Sealants; Momentive Performance Materials Inc.**]

3) [**May National Associates, Inc.; a subsidiary of Sika Corporation**]
4) [**Pecora Corporation**]
5) [**The Dow Chemical Company**]
6) [**Tremco Incorporated**]

2. Urethane, M, NS, 25, T, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Bostik; Arkema**]
2) [**LymTal International, Inc.**]
3) [**Master Builders Solutions**]
4) [**Sika Corporation**]

2.15 FABRICATION OF STONE

A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.

1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
2. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
3. For marble, serpentine, and travertine, comply with recommendations in MIA's "Dimension Stone - Design Manual VII."

B. Control depth of stone and back check to maintain minimum clearance of [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] between backs of stone units and surfaces or projections of structural members, fireproofing (if any), backup walls, and other work behind stone.

C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.

D. Cut and drill sinkages and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone securely in place.

E. Finish exposed faces and edges of stone[**except sawed reveals,**] to comply with requirements indicated for finish and to match approved samples[**and mockups**].

F. Quirk-miter corners unless otherwise indicated; provide for cramp anchorage in top and bottom bed joints of corner pieces.

G. Cut stone to produce uniform joints [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**] wide and in locations indicated.

H. Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.

I. Fabricate molded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length, with precisely formed arris slightly eased to prevent snipping, and with matching profile at joints between units.

1. Produce moldings and molded edges with machines that use abrasive shaping wheels made to reverse contour of molding shape.

J. Carve and cut [**inscriptions**][**and**][**decorative surfaces**]. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.

K. Abrasively etch [**inscriptions**][**and**][**decorative surfaces**].

L. Laser etch [**inscriptions**][**and**][**decorative surfaces**].

M. Clean backs of stone to remove rust stains, iron particles, and stone dust.

N. Inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved samples and mockups.

2.16 FABRICATION OF BACKUP STRUCTURE

A. Fabrication of [**Steel Trusses**][**Strongback Frames**][**and**][**Miscellaneous Steel Framing**]: Fabricate in shop to comply with AISC 303.

1. Weld shop connections to comply with applicable provisions of AWS D1.1/D1.1M.
2. Fabricate joints to exclude water or to permit its escape to building exterior, at locations where water could accumulate because of condensation or other causes.
3. Hot-dip galvanize backup structure after fabrication to comply with ASTM A123/A123M.

B. Fabrication of Steel Stud Frames: Fabricate and assemble by welding to comply with requirements in Section 054000 "Cold-Formed Metal Framing."

1. Weld secondary weather barrier (sheathing) to outside face of steel stud frames. Use continuous welds at all four edges of sheets to provide continuous weather seal.
2. Clean welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

2.17 SHOP-PAINTED STEEL FINISHES

A. Shop-Painted Steel Finishes: Paint uncoated steel backup structure before delivering to Project site to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cloverdale Paint**]
b. [**Coronado Paint; Benjamin Moore & Co.**]
c. [**Dulux (formerly ICI Paints); a brand of AkzoNobel**]
d. [**Frazee Paint; Comex Group**]

e. [**General Paint**]
f. [**Sherwin-Williams Company (The)**]
g. [**SICO; PPG Architectural Coatings**]

B. Surface Preparation: After fabricating steel items, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Apply one coat of fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#76.[**After primer has dried, apply one coat of exterior alkyd enamel complying with MPI#96 of a different color than primer.**]

D. Apply two-coat, high-performance coating system consisting of epoxy zinc-rich primer, complying with MPI#20 and topcoat of high-build epoxy coating, complying with MPI#108.

2.18 MORTAR MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.

1. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated. Do not use calcium chloride.
2. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer unless otherwise indicated. Discard mortar when it has reached initial set.

B. Portland Cement-Lime Setting Mortar: Comply with ASTM C270, Proportion Specification, [**Type S.**][**Type N.**][**for types of mortar indicated below:**]

1. Set granite with Type S mortar.
2. Set limestone with Type N mortar.
3. Set marble with Type S mortar.
4. Set quartz-based stone with [**Type S**][**Type N**] mortar.
5. Set serpentine with Type S mortar.
6. Set slate with Type S mortar.
7. Set travertine with Type N mortar.
8. Backparge travertine with Type O mortar.

C. Pointing Mortar: Comply with ASTM C270, Proportion Specification, [**Type S**][**Type N**][**Type O**][**for types of mortar indicated**]. Provide pointing mortar mixed to match Architect's sample and complying with the following:

1. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
2. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.
3. Colored-Aggregate Pointing Mortar: Produce color required by combining colored aggregates with portland cement of selected color.
4. Point granite with [**Type S**][**Type N**] mortar.
5. Point limestone with [**Type N**][**Type O**] mortar.
6. Point marble with [**Type N**][**Type O**] mortar.
7. Point quartz-based stone with [**Type N**][**Type O**] mortar.
8. Point serpentine with [**Type N**][**Type O**] mortar.
9. Point slate with Type N mortar.
10. Point travertine with [**Type N**][**Type O**] mortar.

2.19 SOURCE QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform source quality-control testing.

1. Retesting of materials that fail to meet specified requirements is done at Contractor's expense.
2. Furnish test specimens [**randomly selected**][**selected by testing agency**] from same blocks as actual materials proposed for incorporation into the Work.
3. Flexural Strength Tests: ASTM C880/C880M, performed on specimens of same thickness, orientation of cut, and finish as installed stone. One set of test specimens is required to be tested for every [**10,000 sq. ft. (1000 sq. m)**][**5000 sq. ft. (500 sq. m)**][**3000 sq. ft. (300 sq. m)**], but not fewer than two sets for each stone variety.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive stone cladding and conditions under which stone cladding will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone cladding.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone cladding.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF BACKUP STRUCTURE

A. Installing [**Steel Trusses**][**Strongback Frames**][**and**][**Miscellaneous Steel Framing**]: Comply with AISC 303 and install to accommodate construction tolerances specified.

1. Maintain erection of backup structure within tolerances in AISC 303.
2. For prefabricated units to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.
3. Install by [**welding to steel weld-plates anchored in concrete**][**bolting to inserts cast into concrete**][**or**][**bolting to structural-steel frame**].
4. Clean welds, bolted connections, and abraded areas immediately after erection.

    a. Repair galvanizing to comply with ASTM A780/A780M.
    b. Apply paint to exposed areas using same material as used for shop painting.

B. Installing Steel Stud Frames: Install [**by welding to steel weld-plates anchored in concrete**][**by welding to structural-steel frame**][**by bolting to structural-steel frame**] to comply with requirements in Section 054000 "Cold-Formed Metal Framing."

1. Install steel stud frames level, plumb, and true to line with no variation in plane or alignment exceeding **1/16 inch (1.5 mm)** and no variation in position exceeding **1/8 inch (3 mm)**.
2. For prefabricated frames to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.
3. Clean welds, bolted connections, and abraded areas immediately after erection. Repair galvanizing to comply with ASTM A780/A780M.

C. Installing Metal-Grid Systems: Comply with manufacturer's written instructions to provide integrated system that combines metal struts, fittings, fasteners, and stone anchors.

1. Fasten struts by bolting to [**inserts in concrete**][**or**][**steel angle clips bolted to steel framing**].
2. Fasten stone supports and anchors by bolting to struts.
3. Shim and adjust struts and stone supports and anchors to provide grid that is level, plumb, and true to line with no variation in plane or alignment exceeding **1/16 inch (1.5 mm)** and no variation in position exceeding **1/8 inch (3 mm)**.

3.3 INSTALLATION OF STONE CLADDING, GENERAL

A. Before setting stone, clean surfaces that are dirty or stained by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

B. Coat limestone with dampproofing to extent indicated below:

1. Stone at Grade: Beds, joints, and back surfaces to at least **12 inches (300 mm)** above finish-grade elevations.
2. Stone Extending Below Grade: Beds, joints, back surfaces, and face surfaces below grade.
3. Allow dampproofing to cure before setting dampproofed stone. Do not damage or remove dampproofing while handling and setting stone.

C. Parge back of travertine panels with mortar not less than **3/8 inch (10 mm)** thick.

D. Execute stone cladding installation by skilled mechanics and employ skilled stone fitters at Project site to do necessary field cutting as stone is set.

1. Use power saws with diamond blades to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.

E. Contiguous Work: Provide reveals, reglets, and openings as required to accommodate contiguous work.

F. Set stone to comply with requirements indicated. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure stone cladding in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated, with uniform joints of widths indicated, and with edges and faces aligned according to established relationships and indicated tolerances.

G. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.

1. Sealing expansion and other joints is specified in Section 079200 "Joint Sealants."
2. Keep expansion joints free of mortar and other rigid materials.

H. Install concealed flashing at continuous shelf angles, lintels, ledges, and similar obstructions to downward flow of water, to divert water to building exterior. Extend flashing **6 inches (150 mm)** at ends and turn up not less than **2 inches (50 mm)** to form end dams.

I. Keep cavities open where unfilled space is indicated between back of stone units and backup wall; do not fill cavities with mortar or grout.

1. Place weep holes in joints where moisture may accumulate, including at base of cavity walls and above shelf angles and flashing. Locate weep holes at intervals not exceeding **24 inches (600 mm)**. Use [**weep and vent tubes**][**plastic weep hole/vents**][**or**][**wicking material**].
2. Place vents in cavity walls at tops of cavities, below shelf angles and flashing, and at intervals not

exceeding **20 feet (6 m)** vertically. Locate vents in joints at intervals not exceeding **60 inches (1500 mm)** horizontally. Use [**weep and vent tubes**][**or**][**plastic weep hole/vents**].

3.4 INSTALLATION OF MECHANICALLY ANCHORED STONE CLADDING

A. Set stone cladding with mechanical anchors without mortar unless otherwise indicated.

B. Attach anchors securely to stone and to backup surfaces. Comply with recommendations in ASTM C1242.

C. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant indicated for filling kerfs.

D. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.

3.5 INSTALLATION OF STONE CLADDING WITH MORTAR

A. Set stone cladding with mortar and mechanical anchors [**where indicated**][**unless otherwise indicated**].

B. Set stone in full bed of mortar with head joints filled unless otherwise indicated.

1. Use setting buttons of adequate size, in sufficient quantity, and of thickness required to maintain uniform joint width and to prevent mortar from extruding. Hold buttons back from face of stone a distance at least equal to width of joint, but not less than depth of pointing materials.
2. Do not set heavy units or projecting courses until mortar in courses below has hardened enough to resist being squeezed out of joint.
3. Support and brace projecting stones until wall above is in place and mortar has set.
4. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.

C. Fill space between back of stone units and backup wall solidly with mortar or grout.

D. Embed ends of sills in mortar; leave remainder of joint open until final pointing.

E. Rake out joints for pointing with mortar to depths of not less than **1/2 inch (12 mm)**. Rake joints to uniform depths with square bottoms and clean sides.

F. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply first layer of pointing mortar in layers not more than **3/8 inch (10 mm)** until a uniform depth is formed.

G. Point stone joints by placing pointing mortar in layers not more than **3/8 inch (10 mm)**. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

H. Tool joints with a round jointer having a diameter **1/8 inch (3 mm)** larger than width of joint, when pointing mortar is thumbprint hard.

I. Rake out mortar from sealant-pointed joints to depths required for sealant and sealant backing, but not less than **1/2 inch (12 mm)**. Rake joints to uniform depths with square bottoms and clean sides.

J. Set the following stone cladding with unfilled head joints for installing joint sealants:

1. Cornices.
2. Copings.
3. Sills.
4. Belt and other projecting courses.

3.6 INSTALLATION OF JOINT-SEALANTS

A. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.7 INSTALLATION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (10 mm in 6 m)**, or **1/2 inch in 40 feet (12 mm in 12 m)** or more. For external corners, corners and jambs within **20 feet (6 m)** of an entrance, expansion joints, and other conspicuous lines, do not exceed **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **3/8 inch in 40 feet (10 mm in 12 m)** or more.

B. Variation from Level: For lintels, sills, water tables, parapets, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **3/8 inch (10 mm)** maximum.

C. Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, do not exceed **1/4 inch in 20 feet (6 mm in 6 m)** or **1/2 inch in 40 feet (12 mm in 12 m)** or more.

D. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus **1/4 inch (6 mm)**.

E. Variation in Joint Width: Do not vary from average joint width more than plus or minus **1/8 inch (3 mm)** or a quarter of nominal joint width, whichever is less. For joints within **60 inches (1500 mm)** of each other, do not vary more than **1/8 inch (3 mm)** or a quarter of nominal joint width, whichever is less from one to the other.

F. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed **1/16-inch (1.5-mm)** difference between planes of adjacent units.

3.8 ADJUSTING AND CLEANING

A. Remove and replace broken, chipped, stained, or otherwise damaged stone, defective joints, and stone cladding that does not match approved samples[**and mockups**]. Damaged stone may be repaired if the Owner approves methods and results.

B. Replace damaged or defective work in a manner that results in stone cladding's matching approved samples[**and mockups**], complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone cladding as work progresses.[**Remove mortar fins and smears before tooling joints.**] Remove excess sealant and smears as sealant is installed.

D. Final Cleaning: Clean stone cladding no fewer than six days after completion of pointing and sealing,

using clean water and stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning agents containing caustic compounds or abrasives, or other materials or methods that could damage stone.

END OF SECTION 04 42 00 00

Task	Specification	Specification Description
04 42 43 00	04 42 00 00	Exterior Stone Cladding
04 43 16 00	01 11 19 00	No Specification Required
04 43 16 00	04 42 00 00	Exterior Stone Cladding
04 51 00 00	04 20 00 00	Unit Masonry

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SECTION 04 72 00 00 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall panels[**with engraved inscriptions**].
2. Trim units.
3. Decorative elements.
4. Mortar materials.
5. Accessories.

B. Related Requirements:

1. Section 034500 "Precast Architectural Concrete."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1. Include building elevations showing layout of units and locations of joints and anchors.

D. Samples for Initial Selection: For colored mortar.

E. Samples for Verification:

1. For each color and texture of cast stone required, [**4 inches (100 mm) square**] in size.
2. For each trim shape required, [**4 inches (100 mm)**] in length.
3. For colored mortar, make Samples using same sand and mortar ingredients to be used on Project.[**Label Samples to indicate types and amounts of pigments used.**]

F. Full-Size Samples: For each [**color**][**texture**][**engraving**][**and**][**shape**] of cast stone unit required.

1. Make available for Architect's review at Project site[**or at manufacturing plant, if acceptable to Architect**].
2. Make Samples from materials to be used for units used on Project[**immediately before beginning production of units for Project**].
3. Approved Samples may be installed in the Work.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**manufacturer**][**and**][**testing agency**].

1. Include copies of material test reports, indicating compliance of cast stone with ASTM C1364.

B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C1364.

1. Provide test reports based on testing within previous six months.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by [**CSI**][**or**][**APA**][**or**][**PCI for Group A, Category AT**].

B. Furnish cast stone for installation in mockups specified in [**Section 042000 "Unit Masonry."**][**Section 042613 "Masonry Veneer."**]

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects[**and to set quality standards for materials and execution**].

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of cast stone[**with unit masonry work**] to avoid delaying the Work[**and to minimize the need for on-site storage**].

B. Pack, handle, and ship cast stone units in suitable packs or pallets.

1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units if required, using dollies with wood supports.
2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.6 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements in TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Cast Stone: Obtain cast stone units from single source from single manufacturer.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

2.2 CAST STONE MATERIALS

A. General: Comply with ASTM C1364.

B. Portland Cement: ASTM C150/C150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C114. Provide natural color or white cement as required to produce cast stone color indicated.

C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C33/C33M; gradation and colors as needed to produce required cast stone textures and colors.

D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C33/C33M, gradation and colors as needed to produce required cast stone textures and colors.

E. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

F. Admixtures: Use only admixtures as directed by the Owner.

1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
3. Air-Entraining Admixture: ASTM C260/C260M.[**Add to mixes for units exposed to the exterior**

at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.]

4. Water-Reducing Admixture: ASTM C494/C494M, Type A.
5. Water-Reducing, Retarding Admixture: ASTM C494/C494M, Type D.
6. Water-Reducing, Accelerating Admixture: ASTM C494/C494M, Type E.

G. Reinforcement:

1. Deformed steel bars complying with ASTM A615/A615M, **Grade 40 (Grade 280)**. Use galvanized or epoxy-coated reinforcement when covered with less than **1-1/2 inches (38 mm)** of cast stone material.

   a. Epoxy Coating: ASTM A775/A775M.
   b. Galvanized Coating: ASTM A767/A767M.

2. Plain-Steel, Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
3. Galvanized-Steel, Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.
4. Fiber Reinforcement: ASTM C1116/C1116M.

H. Embedded Anchors and Other Inserts: Fabricated from [**stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666, Type 304**][**stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666, Type 316**][**steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M**].

2.3 CAST STONE UNITS

A. Regional Materials: Cast stone units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Cast stone units shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Cast stone units shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Cast stone units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Cast stone units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Cast Stone Units: Comply with ASTM C1364.

1. Units are manufactured using the [**manufacturer's selected**][**vibrant dry tamp**][**wet-cast**][**machine-made**] method.
2. Wall Panels: [**Sizes as indicated on Drawings**].

a. Engravings: As indicated on Drawings.

3. Trim units including [**window sills**][**lintels**][**surrounds**][**mullions**][**copings**][**cornices**][**wall caps**][**belt courses**][**water tables**][**quoins**][**keystones**][**items as indicated on Drawings**].
4. Decorative elements including [**pilasters**][**column covers**][**medallions**][**balustrades**][**steps**][**steps and risers**][**bollards**][**benches**][**curbing**][**fountains**][**items as indicated on Drawings**].

G. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
3. Provide drips on projecting elements unless otherwise indicated.

H. Fabrication Tolerances:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than **1/8 inch (3 mm)**.
2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater, but in no case by more than **1/4 inch (6 mm)**.
3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater.
4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than **1/8 inch (3 mm)** on formed surfaces of units and **3/8 inch (10 mm)** on unformed surfaces.

I. Cure Units as Follows:

1. Cure units in enclosed, moist curing room at 95 percent relative humidity and temperature of **100 deg F (38 deg C)** for 12 hours or **70 deg F (21 deg C)** for 16 hours.
2. Keep units damp and continue curing to comply with one of the following:

a. No fewer than five days at mean daily temperature of **70 deg F (21 deg C)** or above.
b. No fewer than seven days at mean daily temperature of **50 deg F (10 deg C)** or above.

J. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

K. Colors and Textures: [**Match Architect's samples**][**Match existing units**][**as directed by the Owner**].

2.4 MORTAR MATERIALS

A. Provide mortar materials that comply with [**Section 042000 "Unit Masonry."**][**Section 042613 "Masonry Veneer."**]

B. Regional Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

H. Hydrated Lime: ASTM C207, Type S.

I. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

J. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Argos USA LLC**]
    b. [**Cemex S.A.B. de C.V.**]
    c. [**Fairborn Cement Company**]
    d. [**Federal White Cement, Ltd.**]
    e. [**Heidelberg Materials**]
    f. [**Holcim (US) Inc**]
    g. [**Lafarge North America Inc.**]
    h. [**Lehigh White Cement Company**]
    i. [**Quikrete; The QUIKRETE Companies, LLC**]
    j. [**Sakrete; CRH Americas, Oldcastle APG**]

K. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Davis Colors**]
    b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    c. [**Lanxess Corporation**]
    d. [**Solomon Colors Inc.**]

L. Colored Cement Products: Packaged blend made from [**portland cement and hydrated**

lime][**masonry cement**][**or**][**mortar cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Argos USA LLC**]
        2) [**Heidelberg Materials**]
        3) [**Holcim (US) Inc**]

2. Colored Masonry Cement:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Argos USA LLC**]
        2) [**Cemex S.A.B. de C.V.**]
        3) [**Fairborn Cement Company**]
        4) [**Heidelberg Materials**]
        5) [**Holcim (US) Inc**]
        6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.

M. Preblended Dry Mortar Mix: Packaged blend made from [**portland cement and hydrated lime**][**masonry cement**][**or**][**mortar cement**], sand, [**mortar pigments,**][**water repellents,**] and admixtures and complying with ASTM C1714/C1714M.

1. Preblended Dry Portland Cement Mortar Mix:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
        2) [**Quikrete; The QUIKRETE Companies, LLC**]
        3) [**Sakrete; CRH Americas, Oldcastle APG**]
        4) [**SPEC MIX, LLC**]

2. Preblended Dry Masonry Cement Mortar Mix:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**SPEC MIX, LLC**]

N. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

O. Water: Potable.

2.5 ACCESSORIES

A. Anchors: Type and size indicated, fabricated from [**Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666**][**Type 316 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666**][**steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M**].

B. Dowels: **1/2-inch- (12-mm-)** diameter round bars, fabricated from [**Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666**][**Type 316 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666**][**steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M**].

C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**EaCo Chem, Inc.**]
c. [**PROSOCO, Inc**]

2.6 MORTAR MIXES

A. Comply with requirements in [**Section 042000 "Unit Masonry"**][**Section 042613 "Masonry Veneer"**] for mortar mixes.

B. Do not use admixtures including pigments, air-entraining agents, accelerators, retarders, water-repellent

agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar unless otherwise indicated.

C. Comply with ASTM C270, Proportion Specification.

1. For setting mortar, use [**Type S**][**Type N**].
2. For pointing mortar, use [**Type N**][**Type O**].

D. Preblended dry mortar mix complying with ASTM C1714/C1714M and capable of producing mortar strength as indicated in ASTM C270.

1. For setting mortar, use [**Type S**][**Type N**].
2. For pointing mortar, use [**Type N**][**Type O**].

E. Pigmented Mortar: Use colored cement product[**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products**].

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.
3. Mix to match Architect's sample, as directed by the Owner.
4. Application: Use pigmented mortar for exposed mortar joints.

F. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample, as directed by the Owner.
2. Application: Use colored-aggregate mortar for exposed mortar joints.

2.7 SOURCE QUALITY CONTROL

A. Engage a qualified independent testing agency to sample and test cast stone units according to ASTM C1364.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING CAST STONE IN MORTAR

A. Set cast stone as indicated in TMS 604.

B. Install cast stone units to comply with requirements in [**Section 042000 "Unit Masonry."**][**Section 042613 "Masonry Veneer."**]

C. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Coordinate installation of cast stone with installation of flashing specified in other Sections.

D. Wet joint surfaces thoroughly before applying mortar or setting in mortar.

E. Set units in full bed of mortar with full head joints unless otherwise indicated.

1. Set units with joints [1/4 to 3/8 inch (6 to 10 mm)][3/8 to 1/2 inch (10 to 13 mm)] wide unless otherwise indicated.
2. Build anchors and ties into mortar joints as units are set.
3. Fill dowel holes and anchor slots with mortar.
4. Fill collar joints solid as units are set.
5. Build concealed flashing into mortar joints as units are set.
6. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.
7. Keep joints at shelf angles open to receive sealant.

F. Rake out joints for pointing with mortar to depths of not less than 3/4 inch (19 mm). Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.

G. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch (10 mm). Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

H. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.

I. Rake out joints for pointing with sealant to depths of not less than 3/4 inch (19 mm). Scrub faces of units to remove excess mortar as joints are raked.

J. Point joints with sealant to comply with applicable requirements in Section 079200 "Joint Sealants."

1. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

K. Provide sealant joints at head joints of copings and other horizontal surfaces; at expansion, control, and pressure-relieving joints; and at locations indicated.

1. Keep joints free of mortar and other rigid materials.
2. Build in compressible foam-plastic joint fillers where indicated.
3. Form joint of width indicated, but not less than [3/8 inch (10 mm)][1/2 inch (13 mm)].
4. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.3 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

A. Set cast stone as indicated in TMS 604.

B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.

C. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.

D. Fill anchor holes with sealant.

1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

E. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

F. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.

1. Form open joint of width indicated, but not less than [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**].

G. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

H. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.4 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed [**1/4 inch in 10 ft. (6 mm in 3 m)**][**1/8 inch in 10 ft. (3 mm in 3 m)**], [**3/8 inch in 20 ft. (10 mm in 6 m)**][**1/4 inch in 20 ft. (6 mm in 6 m)**], or **1/2 inch (12 mm)** maximum.

B. Variation from Level: Do not exceed [**1/4 inch in 10 ft. (6 mm in 3 m)**][**1/8 inch in 10 ft. (3 mm in 3 m)**], [**3/8 inch in 20 ft. (10 mm in 6 m)**][**1/4 inch in 20 ft. (6 mm in 6 m)**], or **1/2 inch (12 mm)** maximum.

C. Variation in Joint Width: Do not vary joint thickness more than **1/8 inch in 36 inches (3 mm in 900 mm)** or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than **1/16 inch (1.5 mm)**, except where variation is due to warpage of units within tolerances specified.

3.5 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved the Owner.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone as work progresses.

1. Remove mortar fins and smears before tooling joints.
2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain the Owner approval of sample cleaning before proceeding with cleaning of cast stone.
3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
5. Clean cast stone by methods described in Cast Stone Institute Technical Bulletin #39.
6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 04 72 00 00

Task	Specification	Specification Description
04 72 00 00	03 41 00 00	Precast Structural Concrete
04 72 00 00	04 20 00 00	Unit Masonry

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SECTION 05 01 70 61 - DECORATIVE METAL REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative metal repairs as follows:

a. Repairing metal and replacing damaged and missing components in place.
b. Removing metal for shop repair and replacement of components; reinstalling repaired metal.
c. Painting steel uncovered during the Work.
d. Installing wood rails supported by or attached to decorative metal railings or brackets.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 057000 "Decorative Metal" for new decorative metal construction.
3. Section 057300 "Decorative Metal Railings" for new decorative handrails and railings.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**]

B. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, methods of attachment, accessory items, and finishes.
2. Include field-verified dimensions and the following:

a. Identification of each new metal item and component and its location on the structure in annotated plans and elevations.
b. Provisions for expansion, weep holes, and conduits as required for each location and exposure.
c. Provisions for sealant joints if required.

C. Samples for Initial Selection: For the following:

1. Each type of decorative metal item and component with applied finishes.
2. Sealant materials.
3. Accessories to verify color selection.

D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:

1. Each type of new material to be used for replacing existing or missing decorative metal; **6 inches (150 mm)** long in least dimension or whole item.
2. Fittings and brackets.
3. Each type of exposed connection between components. Show method of finishing components at connections.
4. Each type of exposed finish prepared on metal of the same alloy to be used for the Work of this Section; **6 inches (150 mm)** long in least dimension.
5. Sealant materials.
6. Accessories: Each type of anchor, accessory, and miscellaneous support in required finishes.

E. Delegated-Design Submittal: For [**structural performance of repaired railings, handrails, and anchors**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For decorative metal repair specialist.

B. Evaluation Reports: For post-installed structural anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Decorative Metal Repair Specialist Qualifications: A qualified decorative metal fabrication and repair specialist. Experience installing and finishing new decorative metalwork is insufficient experience for repairing decorative metal.

1. Single Specialist: Subject to compliance with requirements, engage the same specialist firm to perform the work of [**Section 050170.51 "Decorative Metal Cleaning"**][**Section 050170.63 "Decorative Metal Refinishing"**] and the work of this Section.

B. Mockups: Prepare mockups of decorative metal repair processes[**on existing surfaces**] to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation. Prepare mockups so they are inconspicuous.

1. Replacing Cast-Metal Components: [**Two**] cast-iron [**handrail brackets**][**and**][**grilles**] replaced with exact duplicates.
2. Replacing Cut-Out Metal Items: [**Two**] cut-out bronze-plate [**wall registers**] replaced with exact duplicates.

3. Repairing Wrought Handrail and Railing: [**3 feet (1 m)**] of wrought-iron handrail and railing. [**Patch indentations and reconnect fractures by filling, welding, brazing, or applying new metal material**].
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Pack, deliver, and store decorative metal items in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, cracked, or otherwise damaged.

B. Store decorative metal inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

C. Protect strippable protective covering on decorative metal from exposure to sunlight and high humidity, except to the extent necessary for the period of decorative metal installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with decorative metal repairs only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design post-installed structural anchors.

B. Structural Performance: [**Railings**][**and**][**handrails**], including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
2. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
3. Uniform and concentrated loads need not be assumed to act concurrently.

2.2 METAL MATERIALS

A. General: Provide decorative metal materials made of the alloys, forms, and types that match existing metals and have the ability to receive finishes matching existing finishes unless otherwise indicated. Exposed-to-view surfaces exhibiting imperfections inconsistent with existing materials are unacceptable.

B. Source Limitation for Replacement Cast Materials: Obtain castings for decorative metal repair from single source from single manufacturer with resources to provide materials of consistent quality in appearance and physical properties.

C. Aluminum: Alloy and temper recommended in writing by aluminum producer and finisher for type of use

and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required:

1. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.
2. Extruded Structural Pipe and Tubes: ASTM B429/B429M, Alloy 6063-T6.
3. Drawn General-Purpose Seamless Tubes: **ASTM B210 (ASTM B210M)**, Alloy 6063-T832.
4. Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.
5. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.
6. Castings: ASTM B26/B26M, Alloy A356-T6.

D. Copper Alloys, Bronze: Copper alloy designated below for each form required:

1. Extruded Shapes: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze, 57 percent copper and 40 percent zinc).
2. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper and 40 percent zinc).
3. Seamless Pipe: ASTM B43, Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
4. Seamless Tubes: **ASTM B135 (ASTM B135M)**, Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
5. Composition Bronze Castings: ASTM B62, Alloy UNS No. C83600 ("85-5-5-5" is the common trade name; 85 percent copper and 5 percent each of tin, lead, and zinc).
6. Sand Castings: ASTM B584, Alloy UNS No. C86500 (No. 1 manganese bronze, 58 percent copper, 39 percent zinc, 1 percent manganese, and small amounts of other metals).

E. Copper Alloys, Brass: Copper alloy designated below for each form required:

1. Extruded Shapes: ASTM B249/B249M, Alloy UNS No. C36000 (free-cutting brass, 60 percent copper, 36 percent zinc, and small amounts of other metals).
2. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
3. Seamless Tubes: **ASTM B135 (ASTM B135M)**, Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
4. Sand Castings: ASTM B584, Alloy UNS No. C85200 (high-copper yellow brass, 72 percent copper, 24 percent zinc, and small amounts of other metals).

F. Stainless Steel: Grade designated below for each form required:

1. Tubing: ASTM A554, [**Grade MT-304**][**Grade MT-316**].
2. Pipe: ASTM A312/A312M, [**Grade TP304**][**Grade TP316**].
3. Castings: ASTM A743/A743M, [**Grade CF8 or CF20**][**Grade CF8M**].
4. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].
5. Flat Bar: ASTM A666, [**Type 304**][**Type 316**].
6. Bars and Shapes: ASTM A276, [**Type 304**][**Type 316**].

G. Steel: Standard and grade designated below for each form required:

1. Tubing: Cold formed, ASTM A500/A500M.
2. Steel Plate, Shapes, and Bars: ASTM A36/A36M.
3. Steel Bars: Mild steel; ASTM A29/A29M, Grade 1010.
4. Steel Sheet: ASTM A1008/A1008M, cold-rolled commercial steel sheet; matte finish; suitable for exposed applications.

H. Cast Iron: Standard designated below for each type of casting:

1. Gray-Iron Castings: ASTM A48/A48M, Class 30.
2. Malleable-Iron Castings: ASTM A47/A47M, grade as recommended in writing by fabricator for type of use indicated.

I. Wrought Iron: [**Mild steel; ASTM A29/A29M, Grade 1010**]; hand worked or machine forged to the form indicated.

2.3 PREPARATORY CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Abrasive Materials:

1. Abrasive Pads for Copper-Alloy Cleaning: Extra-fine bronze wool or plastic abrasive pads.
2. Blasting Abrasive: [**Pulverized walnut shells**][**Powdered aluminum silicate**].
3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

E. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

F. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to [**MPI #23 (surface-tolerant, anticorrosive metal primer)**][**or**][**SSPC-Paint 20 or SSPC-Paint 29**].

1. Surface Preparation: Use coating requiring no better than [**SSPC-SP 2, "Hand Tool Cleaning"**][**SSPC-SP 3, "Power Tool Cleaning"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"**] surface preparation according to manufacturer's literature or certified statement.
2. VOC Limit: Use coating with a VOC content of [**400 g/L (3.3 lb/gal.)**] or less.

2.4 FASTENERS

A. Fasteners: Fasteners of the same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal joined.

1. Match existing fasteners in material and in type of fastener unless otherwise indicated.
2. Use concealed fasteners for interconnecting decorative metal components and for attaching them to other work unless exposed fasteners are [**unavoidable**][**or**][**the existing fastening method**].
3. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
4. Finish heads of exposed fasteners to match finish of metal fastened unless otherwise indicated.

B. Anchors, General: Use bolt heads of same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal anchored.

C. Post-Installed Structural Anchors: Fastener systems; with working capacity greater than or equal to the

design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [**AC01**][**AC193**][**AC58**][**or**][**AC308**] as appropriate for the substrate.

1. Uses: Securing [**railings**][**and**][**handrails**] to concrete.
2. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

D. Post-Installed Nonstructural Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [**AC01**][**AC193**][**AC58**][**or**][**AC308**] as appropriate for the substrate.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Wood Rails: Hardwood rails of species and profile [**matching design reference sample**][**matching existing**][**as indicated on Drawings**], complying with [**Section 064013 "Exterior Architectural Woodwork."**][**Section 064023 "Interior Architectural Woodwork."**].

B. Welding Electrodes and Filler Metal: Select according to AWS specifications for metal alloy welded; use metal type and alloy as recommended in writing by producer of metal to be welded or filled and as required for color match, strength, and compatibility in fabricated items.

C. Brazing Rods for Copper-Alloy Components: Type and alloy as recommended in writing by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

D. Brazing Rods for Cast-Iron Components: Type and alloy as recommended in writing by brazing-rod manufacturer and as required for strength and compatibility in fabricated items.

E. Metal-Patching Compound: Two-part, polyester-resin metal-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of metal repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling metal that has deteriorated because of corrosion. Filler shall be capable of filling deep holes and spreading to feather edge.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended in writing by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: [**At exterior locations**][**and**][**where indicated**], provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior use.

H. Sealant Materials:

1. Provide manufacturer's standard, elastomeric [**single-component, nonsag, neutral-curing silicone**][**single-component, nonsag urethane**] sealant complying with applicable requirements in Section 079200 "Joint Sealants."
2. Colors: Provide colors of exposed sealants to match colors of metals in which sealant is placed unless otherwise indicated.

I. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Price Research, Ltd. dba Charles Paint Research**]

J. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces, and that will easily come off entirely, including adhesive.

K. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

a. Remove, alter, or in any way harm the present or future condition of existing surfaces, including surrounding surfaces not in the Contract.
b. Leave an unintended residue on surfaces.

2.6 METAL FABRICATION

A. Metal Fabricators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allen Architectural Metals, Inc**]
b. [**Alloy Casting Co., Inc.**]
c. [**Antique Cast Iron, LLC**]
d. [**Architectural Iron Company, Inc.**]
e. [**Brandywine Forge**]
f. [**f2 Industries**]
g. [**Heritage Cast Iron USA**]
h. [**Historical Arts & Casting, Inc**]
i. [**King Architectural Metals**]

j. [**Olek Lejbzon & Co.**]
k. [**Postville Blacksmith Shop**]
l. [**Robinson Iron**]
m. [**Schiff Architectural Detail**]
n. [**Wiemann Metalcraft**]

B. Fabricate repairs of decorative metal items and components in sizes and profiles to match existing decorative metal, with accurate curves, lines, and angles. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

C. Provide uniform, neat seams with minimum exposure of welds, brazing, solder, and sealant.

D. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for fasteners. Use concealed fasteners where possible; use exposed fasteners to match existing work.

E. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.

1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
2. Remove flux immediately.
3. At exposed connections, match contours of adjoining surfaces, and finish exposed surfaces smooth and blended so no roughness shows after finishing.

F. Castings: Fabricate castings free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

1. Finish castings to match existing decorative metalwork.
2. Replacement Casting for Handrail Bracket: Duplicate existing handrail bracket on the cast-iron railing of first-floor stairs in the lobby. Make molds from this bracket to create new cast-iron brackets.

2.7 FINISHES, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

C. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

2.9 COPPER-ALLOY FINISHES

A. General: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)."

B. Buffed Finish: [**M21 (Mechanical Finish: buffed, smooth specular)**][**M22 (Mechanical Finish: buffed, specular)**].

C. Buffed Finish, Lacquered: [**M22 (Mechanical Finish: buffed, specular; specified clear organic coating)**].

D. Satin Hand-Rubbed Finish: [**M32-M34 (Mechanical Finish: directionally textured, medium satin and hand rubbed)**].

E. Satin Hand-Rubbed Finish, Lacquered: [**M32-M34-06x (Mechanical Finish: directionally textured, medium satin and hand rubbed; specified clear organic coating)**].

F. Satin Finish with Statuary Conversion Coating: [**M32-C55 (directionally textured, medium satin; sulfide conversion coating)**].

1. Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**]

G. Brushed Finish with Patina Conversion Coating: M35-C12-C52 (directionally textured, rotary brushed and buff polished, nonetched cleaned; ammonium sulfate conversion coating).

1. Texture and Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

H. Bright-Relieved Statuary Conversion Coating, Lacquered: M12-C55-M2x-06x (matte finish as cast; sulfide conversion coating; buffed to brighten high spots; specified clear organic coating):

1. Color and Buffing: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

2.10 FERROUS METAL FINISHES

A. Repair Primer: Manufacturer's standard, rust-inhibiting, fast-curing, lead- and chromate-free universal primer, compatible with[**firmly adhered existing paint and**] applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

B. Finish Primer: Primer complying with applicable requirements in [**Section 090190.52 "Maintenance Repainting"**] for finish painting of primed existing metal.

C. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning,

pretreatment, application, and minimum dry film thickness.

2.11 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines from new replacement stainless steel, or blend into finish.

B. Restored Finish: Grind and polish surfaces to produce uniform, directionally textured, polished finish to match [**existing finish**][**Architect's sample**], free of cross scratches.

1. Run grain to match existing metal.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M, No. 4.
4. Dull Satin Finish: ASTM A480/A480M, No. 6.
5. Reflective, Directional Polish: ASTM A480/A480M, No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M, No. 8.

D. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proved to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 DECORATIVE METAL REPAIR, GENERAL

A. Repair Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from [**20 feet (6 m)**][**50 feet (15 m)**] away by Architect.

B. Execution of the Work: In repairing items, disturb remaining existing work as minimally as possible and as follows:

1. Stabilize decorative metal to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
2. Remove deteriorated coatings and corrosion.
3. Sequence work to minimize time before protective coatings are reapplied.
4. Repair items where stabilization is insufficient to stop progress of deterioration.
5. Repair items in place where possible.
6. Replace or reproduce items where indicated or scheduled.
7. Install temporary protective measures to stabilize decorative metal that is indicated to be repaired later.

C. Mechanical Coating Removal: Use gentle methods, such as scraping and wire brushing, that will not abrade metal substrate.

D. Repair Decorative Metal Item: Match existing materials and features.

1. Repair decorative metals by patching, piecing-in, splicing, or otherwise reinforcing metals with new metal matching existing metal.

E. Replace Decorative Metal Component: Where indicated, duplicate and replace items with new metal matching existing metal.

1. Replace heavily deteriorated or missing parts or features of decorative metal with compatible materials, using surviving prototypes to create patterns or molds for duplicate replacements.

3.3 PREPARATORY CLEANING

A. General: Use those methods indicated for each type of decorative metal and its location.

1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being cleaned. Use brushes that are resistant to chemicals being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

    a. Equip units with pressure gages.
    b. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
    c. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
    d. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

B. Water Cleaning: Clean with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray. Supplement with [**natural-fiber**][**or**][**plastic**]-bristle brush. Use small brushes to remove soil from joints and crevices.

C. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution and [**natural-fiber**][**or**][**plastic**]-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.

D. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by light rubbing with abrasive pads and water. [**Rinse with cold water to remove residue. Apply rinse by low-pressure spray**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

E. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [**Rinse with cold-water, low-pressure spray to remove residue**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

1. Pressure and Distance from Surface: Maximum pressure of [**60 psi (415 kPa)**][**100 psi (690 kPa)**][**200 psi (1375 kPa)**] with specified blasting abrasive propelled from a distance of [**6 to 12 inches (152 to 305 mm)**][**12 to 18 inches (305 to 457 mm)**] from surface.
2. Pressure and distance from surface as established by mockup.

F. Chemical Rust Removal:

1. Remove loose rust scale with approved abrasives for ferrous metal cleaning.
2. Apply rust remover with brushes or as recommended in writing by manufacturer.
3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

G. Mechanical Rust Removal:

1. Remove rust with approved abrasives for ferrous metal cleaning.
2. Wipe off residue with mineral spirits and either steel wool or soft rags.
3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.4 REMOVAL, REPAIR, AND REINSTALLATION

A. General: Perform removal work as required in Section 024119 "Selective Demolition" for specific requirements relating to selectively demolishing construction, including decorative metal removal for repair or reinstallation elsewhere.

B. Defects in Painted Metal Surfaces: Repair nonload-bearing defects in existing metal surfaces, including dents and gouges more than [**1/16 inch (1.6 mm)**][**1/8 inch (3 mm)**] deep or [**1/2 inch (13 mm)**][**1 inch (25 mm)**] across, and all holes and cracks by filling with metal-patching compound and sanding smooth. Remove burrs and protruding fasteners. Prime iron and steel surfaces immediately after repair to prevent flash rusting.

C. Reinstalling [**Railing**][**and**][**Fence**] Posts: After posts have been inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave **1/8-inch (3-mm)** buildup sloped away from post.

D. Anchoring Wood Rails: Secure wood rails to metal subrail or brackets from bottom of wood rail as indicated on Drawings. Make fastener heads flush to metal surface.

E. Installing Sealant:

1. After metal reinstallation, keep joints to receive sealant dry and free of debris.
2. Clean and prepare joint surfaces according to Section 079200 "Joint Sealants."[**Prime joint surfaces unless sealant manufacturer recommends against priming.**] Do not allow primer to spill or migrate onto adjoining surfaces.
3. Fill sealant joints with specified joint sealant as recommended in writing by sealant manufacturer and according to Section 079200 "Joint Sealants" and the following:

    a. Install sealant using only proved installation methods that ensure sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding metal.
    b. Do not allow sealant to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining surfaces, particularly rough or sculptural textures. Promptly remove excess and spillage of sealant as the work progresses. Clean adjoining surfaces by means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

4. Cure sealant according to Section 079200 "Joint Sealants."

3.5 PRIMING

A. Repair Primer: Apply immediately after completing a repair.

B. Finish Primer: Apply as soon after cleaning as possible.

3.6 PAINTING STEEL UNCOVERED DURING THE WORK

A. Notify Architect if steel is exposed during metal removal. Where Architect determines that the steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Surface Preparation: Remove paint, rust, and other contaminants according to [**SSPC-SP 2, "Hand Tool Cleaning,"**][**SSPC-SP 3, "Power Tool Cleaning,"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning,"**] as applicable to comply with paint manufacturer's recommended preparation.
2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than [**1/16 inch (1.6 mm)**], notify Architect before proceeding, as directed by the Owner.

3.7 DECORATIVE METAL REPAIR SCHEDULE

A. Treatment for Decorative Railing [**DMR-1**]: Wrought-iron railing and gate.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Repairs: Repair railing and replace missing components with hand-worked [**steel bars**][**wrought iron**].

    a. Apply repair primer immediately after repair.

4. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]
5. Baked-Enamel or Powder-Coat Finish: [**Color as indicated by manufacturer's designations**][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**]

B. Treatment of Decorative Railing [**DMR-2**]: Cast-iron balustrade.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Rust Removal: [**Chemical**][**Mechanical**].
4. Repair: [**Patch with new material by filling, welding, brazing, or applying new metal material with fasteners**].

    a. Apply repair primer immediately after repair.

5. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

C. Treatment of Decorative Railing [**DMR-3**]: Bronze railing with bronze handrail.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Repair: [**Splice new material into deteriorated section**].
4. Bronze Finish: [**Satin finish with statuary conversion coating on railing; satin hand-rubbed finish, lacquered, on handrail**].

D. Treatment of Decorative Railing and Handrail [**DMRH-1**]: Deteriorated bronze handrail on cast-iron railing.

1. Repair: Replace broken cast-iron railing components and repaint railing. Replace entire, deteriorated bronze handrail with shop-fabricated aluminum handrail.
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Railing Finish: Paint as specified in [**Section 090190.52 "Maintenance Repainting."**]

    a. Color: [**As indicated by manufacturer's designations**][**Matching design reference sample**][**Matching Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Handrail Finish:

    a. Aluminum Finish: [**Light bronze anodized**][**Medium bronze anodized**][**Dark bronze anodized**][**Anodized color matching design reference sample**][**Anodized color matching Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**].
    b. Baked-Enamel or Powder-Coat Finish: [**Color as indicated by manufacturer's**

designations][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**].

5. Finish Treatment:

   a. Protective Coating: As specified in Section 050170.63 "Decorative Metal Refinishing."
   b. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

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SECTION 05 01 70 63 - DECORATIVE METAL REFINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes refinishing bare decorative metal surfaces as follows:

1. Refinishing metal in place.
2. Removing metal for shop refinishing; reinstalling refinished metal.
3. Integral metal finishes.
4. Clear protective coatings.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 099423 "Gilding" for gilding on metalwork.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

B. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, and sections showing locations and extent of refinishing work.
2. Include field-verified dimensions.

C. Samples for Initial Selection: For the following:

1. A range of each type of exposed finish prepared on metal of the same alloy matching existing metal.

D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise

indicated, finished as required for use in the Work:

1. Each type of exposed finish prepared on metal of the same alloy matching existing metal; **6 inches (150 mm)** long in least dimension.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For decorative metal refinishing specialist.

1.6 QUALITY ASSURANCE

A. Decorative Metal Refinishing Specialist Qualifications: A qualified decorative metal refinishing specialist.

1. Single Specialist: Subject to compliance with requirements, engage the same specialist firm to perform the work of [**Section 050170.51 "Decorative Metal Cleaning"**][**Section 050170.61 "Decorative Metal Repair"**] and the work of this Section.

B. Mockups: Prepare mockups of decorative metal refinishing processes[**on existing surfaces**] to demonstrate aesthetic effects and to set quality standards for materials and execution. Prepare mockups so they are inconspicuous.

1. Waxing Bronze: Wax a cleaned area [**approximately 2 sq. ft. (0.2 sq. m)**][**as indicated on Drawings**] of [**each type of**] bronze [**sculpture**][**paneling**][**and**][**hardware**].
2. Refinishing Decorative Metal: Refinish [**one**] decorative for each type of metal indicated to be refinished.
3. Repairing Decorative Metal Finish: Repair finish of [**one**] decorative for each type of metal finish indicated to be repaired.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Pack, deliver, and store decorative metal items in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, cracked, or otherwise damaged.

B. Store decorative metal inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

C. Protect strippable protective covering on decorative metal from exposure to sunlight and high humidity, except to the extent necessary for the period of decorative metal installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with decorative metal refinishing only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 PREPARATORY CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Nonacidic Liquid Chemical Cleaner: Manufacturer's standard mildly alkaline liquid cleaner, formulated for removing organic soiling from ordinary building materials, including polished stone, brick, copper, brass, bronze, aluminum, stainless steel, plastics, wood, and glass.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Dumond Chemicals, Inc**]

E. Abrasive Materials:

1. Abrasive Pads for Copper-Alloy Cleaning: Extra-fine bronze wool or plastic abrasive pads.
2. Blasting Abrasive: [**Pulverized walnut shells**][**Powdered aluminum silicate**].
3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

2.2 PROTECTIVE COATING MATERIALS

A. Wax Coating: Inert, high-melting-point wax or wax blend, consisting primarily of [**carnauba**][**or**][**microcrystalline petroleum**] wax[**and no solvents**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BWC Company, Inc. (The)**]
b. [**Fisher Scientific; part of Thermo Fisher Scientific**]
c. [**Real Milk Paint Co.**]
d. [**TALAS**]

B. Organic Coating: Clear, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of methyl methacrylate copolymer with benzotriazole UV inhibitor.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**StanChem, Inc.**]
    b. [**TALAS**]

C. Copper-Alloy Corrosion Inhibitor: Solution of [**1**][**to**][**3**] percent benzotriazole in water.

2.3 MISCELLANEOUS MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Building Restoration Products, Inc.**]
    b. [**Price Research, Ltd. dba Charles Paint Research**]

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces, and that will easily come off entirely, including adhesive.

C. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

    a. Remove, alter, or in any way harm the present or future condition of existing surfaces, including surrounding surfaces not in the Contract.
    b. Leave an unintended residue on surfaces.

2.4 FINISHES, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

A. Unfinished: No applied finish; only preparatory cleaning.

B. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

C. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

2.6 COPPER-ALLOY FINISHES

A. General: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)."

B. Buffed Finish: [**M21 (Mechanical Finish: buffed, smooth specular)**][**M22 (Mechanical Finish: buffed, specular)**].

C. Buffed Finish, Lacquered: [**M22 (Mechanical Finish: buffed, specular; specified clear organic coating)**].

D. Satin Hand-Rubbed Finish: [**M32-M34 (Mechanical Finish: directionally textured, medium satin and hand rubbed)**].

E. Satin Hand-Rubbed Finish, Lacquered: [**M32-M34-06x (Mechanical Finish: directionally textured, medium satin and hand rubbed; specified clear organic coating)**].

F. Satin Finish with Statuary Conversion Coating: [**M32-C55 (directionally textured, medium satin; sulfide conversion coating)**].

1. Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

G. Brushed Finish with Patina Conversion Coating: M35-C12-C52 (directionally textured, rotary brushed and buff polished, nonetched cleaned; ammonium sulfate conversion coating).

1. Texture and Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

H. Bright-Relieved Statuary Conversion Coating, Lacquered: M12-C55-M2x-06x (matte finish as cast; sulfide conversion coating; buffed to brighten high spots; specified clear organic coating):

1. Color and Buffing: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

2.7 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines from new replacement stainless steel, or blend into finish.

B. Restored Finish: Grind and polish surfaces to produce uniform, directionally textured, polished finish to match [**existing finish**][**Architect's sample**], free of cross scratches.

1. Run grain to match existing metal.

2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M, No. 4.
4. Dull Satin Finish: ASTM A480/A480M, No. 6.
5. Reflective, Directional Polish: ASTM A480/A480M, No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M, No. 8.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proved to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 DECORATIVE METAL REFINISHING, GENERAL

A. Refinishing Appearance Standard: Refinished surfaces are to have a uniform appearance as viewed from [**20 feet (6 m)**][**50 feet (15 m)**] away by Architect.

B. Execution of the Work: In refinishing items, disturb remaining existing work as minimally as possible and as follows:

1. Remove dirt and corrosion.
2. Sequence work to minimize time before protective coatings are reapplied.
3. Refinish items in place where possible and according to required appearance.

C. Refinish Decorative Metal Item: Remove existing metal finishes on item unless otherwise indicated[**including integral polished and patinated finishes,**] and reapply them.

D. Repair Finish of Decorative Metal Item: Restore areas of deteriorated or missing finish on item and blend restored finish with existing, adjacent finish[**including integral polished and patinated finishes**].

3.3 PREPARATORY CLEANING

A. General: Use those methods indicated for each type of decorative metal and its location.

1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

    a. Equip units with pressure gages.
    b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
    c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
    d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
    e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

B. Water Cleaning: Clean with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray. Supplement with [**natural-fiber**][**or**][**plastic**]-bristle brush. Use small brushes to remove soil from joints and crevices.

C. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution and [**natural-fiber**][**or**][**plastic**]-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.

D. Nonacidic Liquid Chemical Cleaning: Apply chemical cleaner to surfaces according to chemical-cleaner manufacturer's written instructions.

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of two to three minutes**]
4. Nonferrous Metals: Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Ferrous Metals: Do not rinse ferrous metals with water; neutralize chemical cleaner on ferrous metals as recommended in writing by manufacturer. Dry immediately with clean soft cloths. Follow direction of grain in metal.

E. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by light rubbing with abrasive pads and water. [**Rinse with cold water to remove residue. Apply rinse by low-pressure spray**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove**

residue].

F. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [**Rinse with cold water, low-pressure spray to remove residue.**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

1. Pressure and Distance from Surface: Maximum pressure of [**60 psi (415 kPa)**][**100 psi (690 kPa)**][**200 psi (1375 kPa)**] with specified blasting abrasive propelled from a distance of [**6 to 12 inches (152 to 305 mm)**][**12 to 18 inches (305 to 457 mm)**] from the surface.
2. Pressure and distance from surface as established by mockup.

3.4 PROTECTIVE COATING

A. Protective Hot-Wax Coating:[**Pretreat cleaned copper-alloy surfaces with copper-alloy corrosion inhibitor, wipe off excess with ethanol-saturated rag, and allow surface to dry. If fresh corrosion appears, repeat process.**] Apply wax coating to produce uniform appearance without runs or other surface imperfections.

1. Clean and dry surface being waxed.
2. Preheat surface to about **212 deg F (100 deg C)**; hot enough to melt the wax and remove water vapor and other gases within metal surface, but not hot enough to boil the wax or ignite solvents if any.
3. Apply uniform wax coating to surface, ensuring that wax coverage is complete, including recesses.[**Apply second wax coating following the same process.**]
4. Inspect surface and repair holidays by reheating and applying more wax.
5. Buff waxed surface to a slight shine with a lint-free cloth after wax has cooled to a hazy appearance.

B. Protective Organic Coating:[**Pretreat cleaned copper-alloy surfaces with copper-alloy corrosion inhibitor, wipe off excess with ethanol-saturated rag, and allow surface to dry. If fresh corrosion appears, repeat process.**] Apply organic coating to produce uniform appearance without runs or other surface imperfections.

1. Clean and dry surface being coated.
2. Apply two uniform coats by air-spray method according to manufacturer's written instructions, with interim drying between coats.
3. Apply coating to a total dry film thickness of **1 mil (0.025 mm)**.
4. Protect coated surface from contamination until fully cured.

3.5 REMOVAL, REPAIR, AND REINSTALLATION

A. General: Perform removal, repair, and reinstallation work as required in Section 024119 "Selective Demolition" and Section 050170.61 "Decorative Metal Repair."

3.6 DECORATIVE METAL REFINISHING SCHEDULE

A. Treatment of Decorative Handrail [**DMR-#**] : Tarnished bronze railing with bronze handrail.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: [**Water cleaning**][**Detergent cleaning**][**Chemical cleaning**][**Abrasive blasting**].
3. Bronze Finish: [**Satin finish with statuary conversion coating on railing; satin hand-rubbed**

finish, lacquered, on handrail].

B. Treatment for Bronze Statue Finish [**DMS-#**]: Clean, repair patina finish, and coat statue.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: [**Water cleaning**][**Detergent cleaning**][**Chemical cleaning**][**Abrasive blasting**].
3. Finish Repair: Selectively patinate the [**nose**][**foot**][**and**][**previous metal repairs**] to match the rest of the statue.
4. Protective Coating: Protective [**hot-wax**][**organic**] coating.

END OF SECTION 05 01 70 63

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Task	Specification	Specification Description
05 05 19 00	05 50 00 00	Metal Fabrications
05 05 21 00	05 12 00 00	Structural Steel Framing
05 05 23 00	01 11 19 00	No Specification Required
05 05 23 00	05 12 00 00	Structural Steel Framing
05 05 23 00	05 50 00 00	Metal Fabrications

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SECTION 05 12 00 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Bolts and connectors.
3. Rods.
4. Forged-steel structural hardware.
5. Slide bearings.
6. Shrinkage-resistant grout.
7. Prefabricated building columns.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.
4. [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**][**and**][**Section 099600 "High-Performance Coatings"**] for painting requirements.
5. [**Section 099114 "Exterior Painting (MPI Standards)" and Section 099124 "Interior Painting (MPI Standards)"**][**and**][**Section 099601 "High-Performance Coatings (MPI Standards)"**] for painting requirements.
6. Section 133419 "Metal Building Systems" for structural steel.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A6/A6M with flanges thicker than **1-1/2 inches (38 mm)**.
2. Welded built-up members with plates thicker than **2 inches (50 mm)**.
3. Column base plates thicker than **2 inches (50 mm)**.

D. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint [**whether prequalified or qualified by testing**][**qualified by testing**] , including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated Design Submittals: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data [**signed and sealed by the qualified professional engineer responsible for their preparation**] .

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Health Product Declaration (HPD): For each product.

12. Health Product Declaration (HPD): Provide HPD.

13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

14. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

15. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

16. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

17. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

18. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent

(100 ppm) and certification expiration date.

19. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.6 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For specified shop and field welding.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Mill Test Reports: For structural-steel materials, including chemical and physical properties.

D. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.

E. Source Quality Control Reports: For structural-steel framing.

F. Field Quality Control Reports: For specified tests and inspections.

G. Qualification Statements: For [**Installer**][**fabricator**][**shop-painting applicators**][**professional engineer**][**testing agency**] .

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, [**Category ACSE**][**Category CSE**] .

C. Shop-Painting Applicator Qualifications: Qualified in accordance with AISC's Sophisticated Paint [**Endorsement P1**][**Endorsement P2**][**Endorsement P3**] or to SSPC-QP 3.

D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided the Owner’s testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.

2. ANSI/AISC 341.
3. ANSI/AISC 360.
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

2. Option 2: Fabricator's experienced steel detailer selects or completes connections in accordance with ANSI/AISC 303.

a. Select and complete connections using [**schematic details indicated**][**and**][**ANSI/AISC 360**] .
b. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

3. Option 3 and 3A: Design connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer. Member reinforcement at connections is indicated on Drawings.

a. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

4. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

a. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

C. Moment Connections: [**Type PR, partially**][**Type FR, fully**] restrained.

D. Construction: [**Moment frame**][**Braced frame**][**Shear wall system**][**Combined system of moment frame and braced frame**][**Combined system of moment frame and shear walls**][**Combined system of braced frame and shear walls**][**Combined system of moment frame, braced frame, and shear**

walls] .

2.2 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. W-Shapes: [**ASTM A992/A992M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

C. Channels, Angles, M-Shapes: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

D. Channels, Angles, S-Shapes: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

E. Plate and Bar: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**] .

F. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, **50 ksi (345 MPa)**.

G. Cold-Formed Hollow Structural Sections: [**ASTM A500/A500M, Grade B**][**ASTM A500/A500M, Grade C**][**ASTM A1085/ASTMA1085M**] structural tubing.

H. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847/A847M structural tubing.

I. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

1. Weight Class: [**Standard**][**Extra strong**][**Double-extra strong**] .
2. Finish: [**Black**][**Galvanized**][**Black except where indicated to be galvanized**] .

J. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.

K. Steel Forgings: ASTM A668/A668M.

L. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1 (Type 8.8-1)**, compressible-washer type with plain finish.

B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A490 (Grade A490M)**, Type 1, heavy-hex steel structural bolts [**or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends**] ; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex

carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, **Type 490-1 (Type 10.9-1)**, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Hot-dip zinc coating**][**Mechanically deposited zinc coating**][**Hot-dip or mechanically deposited zinc coating**] .
2. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1 (Type 8.8-1)**, compressible-washer type with [**mechanically deposited zinc coating**][**mechanically deposited zinc coating, baked epoxy-coated**] finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, [**heavy-hex**][**round**] head assemblies, consisting of steel structural bolts with splined ends; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Plain**][**Mechanically deposited zinc coating**] .

E. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

A. Unheaded Anchor Rods: [**ASTM F1554, Grade 36**][**ASTM F1554, Grade 55, weldable**][**ASTM A354**][**ASTM A449**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A36/A36M**] .

1. Configuration: [**Straight**][**Hooked**] .
2. Nuts: **ASTM A563 (ASTM A563M)** [**heavy-**] hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: **ASTM F436 (ASTM F436M)**, Type 1, hardened carbon steel.
5. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

B. Headed Anchor Rods: [**ASTM F1554, Grade 36**][**ASTM F1554, Grade 55, weldable**][**ASTM A354**][**ASTM A449**] , straight.

1. Nuts: **ASTM A563 (ASTM A563M)** [**heavy-**] hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.
3. Washers: **ASTM F436 (ASTM F436M)**, Type 1, hardened carbon steel.
4. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

C. Threaded Rods: [**ASTM A36/A36M**][**ASTM A193/A193M, Grade B7**][**ASTM A354, Grade BD**][**ASTM A449**][**ASTM A572/A572M, Grade 50 (Grade 345)**] .

1. Nuts: **ASTM A63 (ASTM A563M)** [**heavy-**] hex carbon steel.
2. Washers: [**ASTM F436 (ASTM F436M), Type 1, hardened**][**ASTM A36/A36M**] carbon steel.
3. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

2.5 FORGED-STEEL STRUCTURAL HARDWARE

A. Clevises and Turnbuckles: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1035.

B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.

C. Sleeve Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1018.

2.6 SLIDE BEARINGS

A. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Amscot Structural Products Corp.**]
b. [**Fluorocarbon Company Limited**]
c. [**GRM Custom Products**]
d. [**R.J. Watson Bridge & Structural Engineered Systems**]

2. Mating Surfaces: [**PTFE and PTFE**][**PTFE and mirror-finished stainless steel**] .
3. Coefficient of Friction: Not more than [**0.03**][**0.04**][**0.05**][**0.06**][**0.10**][**0.12**] .
4. Design Load: Not less than [**2000 psi (13.7 MPa)**][**5000 psi (34 MPa)**][**6000 psi (41 MPa)**] .

5. Total Movement Capability: [**2 inches (50 mm)**] .

2.7 PRIMER

A. Steel Primer:

1. Comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**][**Section 099114 "Exterior Painting (MPI Standards)" and Section 099124 "Interior Painting (MPI Standards)."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**][**Section 099114 "Exterior Painting (MPI Standards)," Section 099124 "Interior Painting (MPI Standards)," and Section 099601 "High-Performance Coatings (MPI Standards)."**]

2. SSPC-Paint 23, latex primer.

3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer: [**MPI#26**][**MPI#80**][**MPI#134**] .

1. Etching Cleaner: MPI#25, for galvanized steel.

2. Galvanizing Repair Paint: [**MPI#18, MPI#19, or SSPC-Paint 20**][**ASTM A780/A780M**] .

2.8 SHRINKAGE-RESISTANT GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.9 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, [**mechanically thermal cut,**] or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with [**SSPC-SP 1**][**SSPC-SP 2**][**SSPC-SP 3**] .

F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded-Steel Door Frames: Build up welded-steel doorframes attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than **10 inches (250 mm)** o.c. unless otherwise indicated on Drawings.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. [**Do not thermally cut bolt holes or enlarge holes by burning.**]
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.10 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: [**Snug tightened**][**Pretensioned**][**Slip critical**] .

B. Weld Connections: Comply with AWS D1.1/D1.1M [**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.11 PREFABRICATED BUILDING COLUMNS

A. Prefabricated Building Column : Consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Black Rock Fireproof Column, a division of United Steel**]
b. [**Dean Lally LLC / FireTrol Columns**]

2. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

a. Fire-Resistance Rating: [**Four hours**][**Three hours**][**Two hours**][**As indicated on Drawings**] .

2.12 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize [**lintels**][**shelf angles**][**and**][**welded door frames**] attached to structural-steel frame and located in exterior walls.

2.13 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of **2 inches (50 mm)**.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces [**unless indicated to be painted**] .
6. Corrosion-resisting (weathering) steel surfaces.
7. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7 (WAB)/NACE WAB-4.
4. SSPC-SP 14 (WAB)/NACE WAB-8.
5. SSPC-SP 11.
6. SSPC-SP 6 (WAB)/NACE WAB-3.
7. SSPC-SP 10 (WAB)/NACE WAB-2.
8. SSPC-SP 5 (WAB)/NACE WAB-1.
9. SSPC-SP 8.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner [**or in accordance with SSPC-SP 16**] .

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of **1.5 mils (0.038 mm)**. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.14 SOURCE QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

2. Bolted Connections: Inspect [**and test**] shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E165/E165M.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94/E94M.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.

    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.

5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

    1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

    1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION OF STRUCTURAL-STEEL FRAMING

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Rods: [**Snug-tighten**][**Pretension**] anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Shrinkage-Resistant Grout: Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. [**Comply with manufacturer's written installation instructions for grouting.**]

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection [**unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M**], as directed by the Owner.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: [**Snug tightened**][**Pretensioned**][**Slip critical**] .

B. Weld Connections: Comply with AWS D1.1/D1.1M [**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs [**where indicated**] , back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.5 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 REPAIR

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting:

1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Cleaning and touchup painting are specified in [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

C. Touchup Priming: Cleaning and touchup priming are specified in [**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

3.7 FIELD QUALITY CONTROL

A. Special Inspections: the Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect [**and test**] bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

    a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

        1) Liquid Penetrant Inspection: ASTM E165/E165M.
        2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
        3) Ultrasonic Inspection: ASTM E164.
        4) Radiographic Inspection: ASTM E94/E94M.

3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

    b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 05 12 00 00

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Task	Specification	Specification Description
05 12 23 00	05 12 00 00	Structural Steel Framing
05 12 23 00	05 40 00 00	Cold-Formed Metal Framing
05 12 23 00	05 50 00 00	Metal Fabrications
05 12 33 00	05 12 00 00	Structural Steel Framing
05 13 00 00	05 12 00 00	Structural Steel Framing
05 13 00 00	05 50 00 00	Metal Fabrications
05 14 13 00	01 11 19 00	No Specification Required

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SECTION 05 15 16 00 - DECORATIVE METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative window security bars.
2. Decorative mechanical grilles and frames.
3. Custom door pulls.
4. Combination hall push-button stations.
5. Metal reveals at wood paneling.
6. Cast-metal rosettes at marble joints.

B. Related Requirements:

1. Section 057300 "Decorative Metal Railings" for decorative metal railings.
2. Section 057500 "Decorative Formed Metal" for decorative metal items made from sheet metal.

1.2 COORDINATION

A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show fabrication and installation details for decorative metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.

E. Samples for Initial Selection: For products involving selection of color, texture, or design[**including mechanical finishes**].

F. Samples for Verification: For each type of exposed finish.

1. Sections of linear shapes.
2. Full-size Samples of castings and forgings.

a. For custom castings, submit finished Samples showing ability to reproduce detail[**, cast-metal color,**] and quality of finish.[**Samples may be of similar previous work.**]

3. Samples of [**welded**][**and**][**brazed**] joints showing quality of workmanship[**and color matching of materials**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**fabricator**][**organic-coating applicator**][**anodic finisher**][**powder-coating applicator**].

B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Installer Qualifications: Fabricator of products.

C. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by enough packing material to ensure that products are not cracked or otherwise damaged.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Use materials with smooth, flat surfaces unless otherwise indicated. Use materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.2 ALUMINUM

A. Fabricate products from alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

B. Bars and Shapes: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

C. Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.

D. Tubing: **ASTM B210 (ASTM B210M)**, Alloy 6063-T832.

E. Plate and Sheet: **ASTM B209 (ASTM B209M)**, [**Alloy 3003-H14**][**Alloy 5005-H32**][**Alloy 6061-T6**].

F. Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.

G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.3 COPPER AND COPPER ALLOYS

A. Fabricate products from alloys indicated and temper to suit application and forming methods but with

strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.

2.4 BRONZE

A. Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).

B. Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).

C. Tube: **ASTM B135 (ASTM B135M)**, Alloy UNS C23000 (red brass, 85 percent copper).

D. Castings: [**ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)**][**or**][**ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)**].

E. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

2.5 BRASS

A. Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).

B. Seamless Tube: **ASTM B135 (ASTM B135M)**, Alloy UNS C26000 (cartridge brass, 70 percent copper).

C. Castings: ASTM B584, Alloy UNS C85200 (high-copper yellow brass).

D. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

2.6 NICKEL SILVER

A. Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.

B. Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).

2.7 COPPER

A. Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high residual phosphorous copper).

B. Castings: ASTM B824, with a minimum of 99.9 percent copper.

C. Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

2.8 STAINLESS STEEL

A. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**][**Grade MT 316L**].

B. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316**][**Grade TP 316L**].

C. Castings: ASTM A743/A743M, [**Grade CF 8 or Grade CF 20**][**Grade CF 8M or Grade CF 3M**].

D. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

E. Flat Bar: ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

F. Bars and Shapes: ASTM A276, [**Type 304**][**Type 316**][**Type 316L**].

G. Wire Rope and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carl Stahl DecorCable, Inc.**]
   b. [**Esmet, Inc.**]
   c. [**Feeney Inc.**]
   d. [**Hayn Enterprises, LLC**]
   e. [**Johnson, C. Sherman, Co., Inc**]
   f. [**Ronstan International Inc**]
   g. [**Seco South, Inc.**]

2. Wire Rope: [**1-by-19**][**7-by-7**][**7-by-19**] wire rope made from wire complying with ASTM A492, Type 316.
3. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain without failure a load equal to minimum breaking strength of wire rope with which they are used.

2.9 STEEL AND IRON

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513, Type 5 (mandrel drawn)**].

C. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

D. Plates, Shapes, and Bars: ASTM A36/A36M.

E. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M unless otherwise indicated.

F. Steel Sheet, Cold Rolled: ASTM A1008/A1008M, either commercial steel or structural steel, exposed.

2.10 TITANIUM

A. Strip, Sheet, and Plate: ASTM B265, Grade 1.

B. Bars: ASTM B348, Grade 1.

2.11 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:

1. Aluminum Items: [**Aluminum**][**Type 304 stainless steel**][**Type 316 stainless steel**] fasteners.
2. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed, muntz metal (Alloy 280) fasteners where exposed**].
3. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed, brass (Alloy 260 or 360) fasteners where exposed**].
4. Stainless Steel Items: [**Type 304**][**Type 316**] stainless steel fasteners.
5. Titanium Items: [**Type 304**][**Type 316**] stainless steel fasteners.
6. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless steel fasteners where exposed.
7. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating.
8. Dissimilar Metals: [**Type 304**][**Type 316**] stainless steel fasteners.

B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable**].

1. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5 unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.12 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

F. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

G. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

H. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

I. Shop Primer for Galvanized Steel: [**Cementitious galvanized metal primer complying with MPI#26**][**Vinyl wash primer complying with MPI#80**][**Water-based galvanized metal primer complying with MPI#134**].

J. Intermediate Coats and Topcoats for Steel: Provide products that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

K. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.

L. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.

M. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.13 FABRICATION, GENERAL

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.
3. Use connections that maintain structural value of joined pieces.

B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged.

1. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes.
2. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

C. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

F. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

G. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to

weather in a manner to exclude water.

H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

I. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

J. Comply with AWS for recommended practices in shop [**welding**][**and**][**brazing**]. [**Weld**][**and**][**braze**] behind finished surfaces without distorting or discoloring exposed side. Clean exposed [**welded**][**and**][**brazed**] joints of flux, and dress exposed and contact surfaces.

1. Where [**welding**][**and**][**brazing**] cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Type 1 Welds: no evidence of a welded joint**][**Type 2 Welds: completely sanded joint, some undercutting and pinholes okay**][**Type 3 Welds: partially dressed weld with spatter removed**][**Type 4 Welds: good quality, uniform undressed weld with minimal splatter**].

K. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

2.14 FABRICATION OF DECORATIVE WINDOW SECURITY BARS

A. Fabricate decorative window grilles to designs indicated from steel bars and shapes of sizes and profiles indicated. Form steel bars by bending, forging, coping, mitering, and welding.

B. Welding: Interconnect grille members with full-length, full-penetration welds unless otherwise indicated. Use welding method that is appropriate for metal and finish indicated and that develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.

C. Brackets, Fittings, and Anchors: Provide wall brackets, fittings, and anchors to connect decorative window grilles to other work unless otherwise indicated.

1. Furnish inserts and other anchorage devices to connect decorative window grilles to concrete and masonry work. Coordinate anchorage devices with supporting structure.
2. Fabricate anchorage devices that are capable of withstanding loads indicated.

2.15 DECORATIVE MECHANICAL GRILLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Architectural Grille**]
2. [**Beaux-Arts Classic Products**]
3. [**DLSS Manufacturing**]
4. [**H&K Perforating LLC**]
5. [**Precision Metal Fabricators, Inc.**]
6. [**Reggio Register Company, Inc.**]
7. [**Register & Grille Mfg. Co., Inc.**]

B. Fabricate decorative grilles from perforated [**aluminum**][**brass**][**bronze**][**stainless steel**][**steel**] sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.

1. Form perforations to match existing grilles.
2. Drawings indicate perforated metal patterns required and are based on products of one manufacturer. Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

C. Drill and countersink grilles for mounting screws at **2 inches (50 mm)** from corners and at **10 inches (250 mm)** or less o.c. Provide units with oval-head [**wood**][**self-tapping machine**] screws.

D. Fabricate grille frames from extruded [**aluminum**][**brass**][**bronze**][**stainless steel**][**steel**] of profiles and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates [**welded**][**brazed**] to back of frames.

1. Secure grilles in frames with **0.5-inch- (12-mm-)** long [**welds**][**brazing**] along perimeter of grilles at **4 inches (100 mm)** o.c.
2. Provide frame profiles to match existing frames.
3. Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

E. Drill and countersink frames for mounting screws at **4 inches (100 mm)** from corners and at **16 inches (400 mm)** or less o.c. Provide units with oval-head [**wood**][**self-tapping machine**] screws.

2.16 FABRICATION OF CUSTOM DOOR PULLS

A. Fabricate custom door pulls from [**brass**][**bronze**][**stainless steel**] bar stock of profile indicated, fabricated to shapes indicated.

1. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces.
2. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile.
3. Drill and tap door pulls to receive through bolts for attachment to doors.

B. Fabricate backing plates for custom door pulls from **1/8-inch (3.2-mm)** [**brass**][**bronze**][**stainless steel**] sheet.

1. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal.
2. Drill and countersink holes where indicated for screws and bolts.

C. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.

2.17 FABRICATION OF COMBINATION HALL PUSH-BUTTON STATIONS

A. Fabricate units of [**brass**][**bronze**][**stainless steel**] to comply with details indicated. Coordinate with elevator signal equipment to provide integrated, closely fitted assemblies.

1. Fabricate faceplates from **1/8-inch- (3.2-mm-)** thick sheet with edges beveled at a 45-degree

angle for one-half thickness of metal.

2. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal **4-inch (100-mm)** wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are **10 by 10 by 3-1/2 inches (250 by 250 by 90 mm)** in depth.
3. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of **1/16 inch (1.6 mm)** with engraving painted red. Make signs **5 inches (125 mm)** wide by **8 inches (200 mm)** high.
4. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station[**, card reader,**] and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.

2.18 FABRICATION OF METAL REVEALS

A. Fabricate metal reveals for wood paneling from [**3/4-by-3/4-by-1/16-inch (19-by-19-by-3-mm) extruded-bronze**][**3/4-by-3/4-by-0.025-inch (19-by-19-by-0.6-mm) brake-formed, stainless steel**][**3/4-by-3/4-by-0.015-inch (19-by-19-by-0.4-mm) brake-formed titanium**] channels.

1. Drill for mounting screws **6 inches (150 mm)** from ends of channels and not more than **24 inches (600 mm)** o.c.
2. Locate mounting screws at same heights for all channels.
3. Provide [**black-finished,**]hex-socket, wafer-head screws for mounting reveals.

2.19 FABRICATION OF CAST-METAL ROSETTES

A. Fabricate cast-metal rosettes to design indicated from [**aluminum**][**brass**][**bronze**][**nickel silver**]. Drill and tap castings for threaded mounting studs.

1. Provide custom castings to match design indicated.
2. Manufacturer's stock castings may be considered, provided deviations are minor and do not change design concept as directed by the Owner.
3. Drawings indicate cast-metal rosette designs required and are based on products of one manufacturer. Castings produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

2.20 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.21 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
2. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Superior-Performance Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.22 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).

D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).

F. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

I. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**, with color matching Architect's sample**].

K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate)[**, with color matching Architect's sample**].

L. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below)[**, with color matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

M. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air dried; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below)[**, with blackening and buffing matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

2.23 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirror-like finish**][**to match Architect's sample**].

D. Stainless Steel Sheet and Plate Finishes:

1. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.
2. Directional Satin Finish: ASTM A480/A480M, No. 4.
3. Dull Satin Finish: ASTM A480/A480M, No. 6.
4. High Luster Finish: ASTM A480/A480M, No. 7.
5. Mirror Finish: ASTM A480/A480M, No. 8.

E. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

F. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.

G. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.

1. Product: Subject to compliance with requirements, provide INCO colored stainless steel finish as developed and licensed by International Nickel Co., Ltd.
2. Color: [**Match Architect's sample**][**As selected by Architect from finisher's full range**].

2.24 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A123/A123M.

1. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A153/A153M.
2. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

C. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

D. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated ferrous-metal surfaces with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting."**][**primers specified in Section 099123 "Interior Painting."**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-**

Performance Coatings" are] indicated.
2. Do not apply primer to galvanized surfaces.

E. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Powder-Coat Finish, Nongalvanized: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. Powder-Coat Finish, Galvanized: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.25 TITANIUM FINISHES

A. General: Fabricate items from finished titanium stock, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.

B. Dull Matte Finish: Pickled and annealed.

C. Bright Matte Finish: Vacuum annealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

H. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.

I. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 INSTALLATION OF DECORATIVE WINDOW SECURITY BARS

A. Fasten security bar frames to concrete and masonry walls with cast-in-place or post-installed anchors. Peen exposed threads of anchors to prevent removal of security bars.

3.4 INSTALLATION OF DECORATIVE MECHANICAL GRILLES

A. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.

1. Secure to framing and blocking with specified fasteners.
2. On marble, brick, and other solid surfaces, secure with wood screws in plastic plugs.

3.5 INSTALLATION OF DECORATIVE-METAL-CLAD, HOLLOW-METAL DOORS AND FRAMES

A. Install doors and frames to comply with requirements specified in Section 081113 "Hollow Metal Doors and Frames."

3.6 INSTALLATION OF CUSTOM DOOR PULLS

A. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head [**wood**][**self-tapping metal**] screws and secure pulls through doors and backing plates with oval-head machine screws.

3.7 INSTALLATION OF COMBINATION HALL PUSH-BUTTON STATIONS

A. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components. Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.

3.8 INSTALLATION OF METAL REVEALS AT WOOD PANELING

A. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.

3.9 INSTALLATION OF CAST-METAL ROSETTES AT MARBLE JOINTS

A. Install cast-metal rosettes at intersections of marble joints where indicated. Install only after marble work is complete and joints are grouted. Secure to wall by drilling a **3/4-inch- (19-mm-)** round hole at intersection of marble joints and by filling hole with molding plaster into which threaded stud is embedded. Angle drill and rotate so bottom of hole is larger than at surface.

1. Secure rosettes in place with masking tape until plaster sets. After plaster has set, remove masking tape and adhesive residue.

3.10 CLEANING AND PROTECTION

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

E. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.

F. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 15 16 00

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Task	Specification	Specification Description
05 15 16 00	05 50 00 00	Metal Fabrications
05 15 19 00	05 15 16 00	Decorative Metal

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SECTION 05 21 00 00 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel joists and joist girders.
2. Primers.
3. Steel joist accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.2 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Mill Certificates: For each type of bolt.

D. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

E. Field quality control reports.

F. Qualification Statements: For [**manufacturer**] [**Erector**] [**testing agency**].

G. Delegated Design Engineer Qualifications: For steel joist framing.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**]

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Erector Qualifications: An experienced Erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

D. Welding Qualifications: Qualify field-welding procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**]

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.7 SEQUENCING

A. Deliver steel bearing plates to be built into [**cast-in-place concrete**] [**and**] [**masonry**] construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design steel joist framing.

B. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.

1. Use [**ASD; data are given at service-load level**] [**LRFD; data are given at factored-load level**].
2. Design special joists to withstand design loads with live-load deflections no greater than the following:

    a. Floor Joists: Vertical deflection of [**1/360**] [**1/240**] of the span.
    b. Roof Joists: Vertical deflection of [**1/360**] [**1/240**] of the span.

2.2 STEEL JOISTS AND JOIST GIRDERS

A. K-Series Steel Joist: Manufactured steel joists of type indicated in accordance with "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: [**K-series steel joists**] [**and**] [**KCS-type K-series steel joists**].
2. K-Series Steel Joist Substitutes: Manufactured in accordance with "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
3. Provide holes in chord members for connecting and securing other construction to joists.
4. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
5. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends as indicated on Drawings, complying with SJI's "Specifications."
6. Do not camber joists.
7. Camber joists [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**]
8. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

B. Long-Span Steel Joist: Manufactured in accordance with "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements[**as follows:**][**as indicated on Drawings.**]

1. Joist Type: [**LH-series long-span steel joists**] [**and**] [**DLH-series long-span steel joists**].
2. End Arrangement: [**Underslung**] [**Square**].
3. Top-Chord Arrangement: [**Parallel**] [**Pitched 1/8 inch per 12 inches (1:96), one way**] [**Pitched 1/8 inch per 12 inches (1:96), two ways**].
4. Provide holes in chord members for connecting and securing other construction to joists.
5. Camber long-span steel joists [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**].
6. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

C. Composite Steel Joist: Manufactured in accordance with "Standard Specifications for Composite Steel Joists, CJ-Series" in SJI's "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice," with steel-angle top- and bottom-chord members and parallel top chord, and with [**underslung**] [**square**] ends.

1. Camber composite steel joists [**as indicated on Drawings**]

D. Joist Girders: Manufactured in accordance with "Standard Specification for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements[**as follows:**][**as indicated on Drawings.**]

1. End Arrangement: [**Underslung**] [**Underslung with bottom-chord extensions**] [**Square**].

2. Top-Chord Arrangement: [**Parallel**] [**Pitched 1/8 inch per 12 inches (1:96), one way**] [**Pitched 1/8 inch per 12 inches (1:96), two ways**].
3. Provide holes in chord members for connecting and securing other construction to joist girders.
4. Camber joist girders [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**].
5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.3 PRIMERS

A. Primer:

1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
2. Provide shop primer that complies with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

2.4 STEEL JOIST ACCESSORIES

A. Bridging:

1. Provide bridging anchors and number of rows of [**horizontal**] [**or**] [**diagonal**] bridging of material, size, and type required by SJI's "Specifications"[**and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice"**] for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
2. Detail and fabricate in accordance with SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**] Furnish additional erection bridging if required for stability.
3. Fabricate as indicated on Drawings and in accordance with SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**] Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings. [**Shop prime paint**] [**Hot-dip zinc coat in accordance with ASTM A123/A123M**].

C. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."

D. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.

1. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated on Drawings.
2. Finish: [**Plain, uncoated**] [**Hot-dip zinc coating, ASTM A153/A153M, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

E. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563/A563M, Grade DH (Grade 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM A153/A153M, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

F. Welding Electrodes: Comply with AWS standards.

G. Galvanizing Repair Paint: [**MPI#18, MPI#19, or SSPC-Paint 20**] [**ASTM A780/A780M**].

H. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by [**hand-tool cleaning, SSPC-SP 2**] [**or**] [**power-tool cleaning, SSPC-SP 3**].

B. Do not prime paint joists and accessories[**to receive sprayed fire-resistive materials**].

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.

D. Shop priming of joists and joist accessories is specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF STEEL JOISTS AND JOIST GIRDERS

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction in accordance with SJI's "Specifications[**,"**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice,"**] joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel [**bearing plates**] [**and**] [**framework**]. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting:

1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists[**, bearing plates,**] [**abutting structural steel,**] and accessories.

    a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
    b. Apply a compatible primer of same type as primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds in accordance with AWS D1.1/D1.1M.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports.

END OF SECTION 05 21 00 00

Task	Specification	Specification Description
05 21 19 00	05 21 00 00	Steel Joist Framing

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SECTION 05 31 00 00 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.
2. Acoustical roof deck.
3. Composite floor deck.
4. Electrified cellular floor deck.
5. Noncomposite form deck.
6. Noncomposite vented form deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck.
3. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
4. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.
2. Acoustical roof deck.
3. Composite floor deck.
4. Electrified cellular floor deck.
5. Noncomposite form deck.
6. Noncomposite vented form deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Health Product Declaration (HPD): For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Test and Evaluation Reports:

1. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

a. Power-actuated mechanical fasteners.
b. Acoustical roof deck.

2. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

E. Qualification Statements: For [**welding personnel**][**and**][**testing agency**].

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

B. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.

C. FM Approvals' RoofNav Listing: Provide steel roof deck evaluated by FM Approvals and listed in its "RoofNav" for Class 1 fire rating and [**Class 1-60**][**Class 1-75**][**Class 1-90**] windstorm ratings. Identify materials with FM Approvals Certification markings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Epic Metals Corporation**]
7. [**Marlyn Steel Decks, Inc.**]
8. [**Miami Metal Deck**]
9. [**New Millennium Building Systems, LLC**]
10. [**OEG Building Materials Inc**]
11. [**Roof Deck, Inc**]
12. [**Tristate Decking, Inc.**]
13. [**Valley Joist**]
14. [**Verco Decking, Inc.; a Nucor company**]
15. [**Vulcraft Group; Division of Nucor Corp.**]
16. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

4. Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792/A792M, Structural Steel (SS), Grade **33 (230)** minimum, **AZ50 (AZ150)** aluminum-zinc-alloy coating.
5. Deck Profile: [**As indicated**][**Type NR, narrow rib**][**Type IR, intermediate rib**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**].
6. Cellular Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**], with bottom plate.
7. Profile Depth: [**As indicated**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**7-1/2 inches (190 mm)**].
8. Design Uncoated-Steel Thickness: [**As indicated**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**][**0.0747 inch (1.90 mm)**].
9. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**As indicated**][**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0474/0.0474 inch (1.20/1.20 mm)**][**0.0474/0.0598 inch (1.20/1.52 mm)**][**0.0598/0.0474 inch (1.52/1.20 mm)**][**0.0598/0.0598 inch (1.52/1.52 mm)**].
10. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
11. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].

2.3 ACOUSTICAL ROOF DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**DACS, Inc.**]
5. [**Epic Metals Corporation**]
6. [**Marlyn Steel Decks, Inc.**]
7. [**Miami Metal Deck**]
8. [**Roof Deck, Inc**]
9. [**Vulcraft Group; Division of Nucor Corp.**]

B. Fabrication of Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, shop primed with manufacturer's standard baked-on, rust-

inhibitive primer.

a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

4. Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792/A792M, Structural Steel (SS), Grade **33 (230)** minimum, **AZ50 (AZ150)** aluminum-zinc-alloy coating.
5. Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**].
6. Cellular Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**], with bottom plate.
7. Profile Depth: [**As indicated**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (76 mm)**][**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**7-1/2 inches (190 mm)**].
8. Design Uncoated-Steel Thickness: [**As indicated**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
9. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**As indicated**][**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0474/0.0358 inch (1.20/0.91 mm)**][**0.0474/0.0474 inch (1.20/1.20 mm)**][**0.0474/0.0598 inch (1.20/1.52 mm)**][**0.0598/0.0474 inch (1.52/1.20 mm)**][**0.0598/0.0598 inch (1.52/1.52 mm)**].
10. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
11. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].
12. Acoustical Perforations: [**Deck units with manufacturer's standard perforated vertical webs**][**Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck**].
13. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.

a. Factory install sound-absorbing insulation into cells of cellular deck.

14. Acoustical Performance: NRC [**0.65**][**0.75**][**0.80**][**0.85**][**0.90**], tested in accordance with ASTM C423.

2.4 COMPOSITE FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Epic Metals Corporation**]
7. [**Marlyn Steel Decks, Inc.**]
8. [**Miami Metal Deck**]
9. [**New Millennium Building Systems, LLC**]
10. [**OEG Building Materials Inc**]

11. [**Roof Deck, Inc**]
12. [**Tristate Decking, Inc.**]
13. [**Verco Decking, Inc.; a Nucor company**]
14. [**Vulcraft Group; Division of Nucor Corp.**]
15. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with SDI C, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard [**gray**][**or**][**white**] baked-on, rust-inhibitive primer.
2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G30 (Z90)**][**G60 (Z180)**] zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.
4. Profile Depth: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**As indicated**].
5. Design Uncoated-Steel Thickness: [**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
6. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].

2.5 ELECTRIFIED CELLULAR FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cordeck**]
2. [**HH Robertson**]

B. Source Limitations for Electrified Cellular Floor Deck: Obtain cellular floor-deck units and compatible electrical components, such as preset inserts, activation kits, afterset inserts, service fittings, header ducts, and trench header ducts, from single manufacturer.

C. Fabrication of Electrified Cellular Floor Deck: Fabricate steel sheet cellular floor-deck panels, consisting of a ribbed top section welded to a lower flat-bottom sheet with interlocking side laps, to comply with SDI C. Fabricate deck to the minimum section properties, width of panel, number, and area of cells per panel indicated.

1. Cellular Deck Type: [**Composite**][**Noncomposite**].
2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, **G60 (Z180)** zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.
4. Profile Depth: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**As indicated**].
5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0358/0.0598 inch (0.91/1.52 mm)**][**0.0474/0.0358**

inch (1.20/0.91 mm)][0.0474/0.0474 inch (1.20/1.20 mm)][0.0474/0.0598 inch (1.20/1.52 mm)][0.0598/0.0474 inch (1.52/1.20 mm)][0.0598/0.0598 inch (1.52/1.52 mm)].

6. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
7. Factory punch holes, of size and arrangement indicated, into each deck cell at preset inserts and header duct locations.

2.6 NONCOMPOSITE FORM DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Marlyn Steel Decks, Inc.**]
7. [**Miami Metal Deck**]
8. [**New Millennium Building Systems, LLC**]
9. [**OEG Building Materials Inc**]
10. [**Roof Deck, Inc**]
11. [**Valley Joist**]
12. [**Verco Decking, Inc.; a Nucor company**]
13. [**Vulcraft Group; Division of Nucor Corp.**]
14. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Noncomposite Form Deck: Fabricate ribbed-steel sheet noncomposite deck panels used as a form to comply with SDI NC, with the minimum section properties indicated, and with the following:

1. Uncoated Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum.
2. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, with[**top and**] underside surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

3. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
4. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

5. Profile Depth: [**9/16 inch (14 mm)**][**15/16 inch (24 mm)**][**1-5/16 inches (33 mm)**][**1-1/2 inches (38 mm)**].
6. Design Uncoated-Steel Thickness: [**0.0149 inch (0.38 mm)**][**0.0179 inch (0.45 mm)**][**0.0239 inch (0.61 mm)**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
7. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
8. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].

2.7 NONCOMPOSITE VENTED FORM DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Marlyn Steel Decks, Inc.**]
4. [**Miami Metal Deck**]
5. [**New Millennium Building Systems, LLC**]
6. [**Roof Deck, Inc**]
7. [**Verco Decking, Inc.; a Nucor company**]
8. [**Vulcraft Group; Division of Nucor Corp.**]
9. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Noncomposite Vented Form Deck: Fabricate ribbed- and vented-steel sheet noncomposite deck panels used as a form to comply with SDI NC, and with the following:

1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
2. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**] zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

3. Profile Depth: [**9/16 inch (14 mm)**][**15/16 inch (24 mm)**][**1-5/16 inches (33 mm)**][**1-1/2 inches (38 mm)**].
4. Design Uncoated-Steel Thickness: [**0.0149 inch (0.38 mm)**][**0.0179 inch (0.45 mm)**][**0.0239 inch (0.61 mm)**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
5. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
6. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].
7. Vent Slot Area: Manufacturer's standard vent slots providing [**1-1/2**] percent open area.

2.8 ACCESSORIES

A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, **No. 10 (4.8-mm)** minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, not less than **0.0359-inch (0.91-mm)** design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, of same material and finish as deck, and of thickness and profile [**indicated**][**recommended by SDI standards for overhang and slab depth**].

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, [**0.0598 inch (1.52 mm)**][**0.0747 inch (1.90 mm)**] thick, with factory-punched hole of **3/8-inch (9.5-mm)** minimum diameter.

J. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

K. Flat Sump Plates: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck. For drains, cut holes in the field.

L. Recessed Sump Pans: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck, with **3-inch- (76-mm-)** wide flanges and [**level**][**sloped**] recessed pans of **1-1/2-inch (38-mm)** minimum depth. For drains, cut holes in the field.

M. Galvanizing Repair Paint: [**ASTM A780/A780M**][**SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight**].

N. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

J. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than **1-1/2 inches (38 mm)** long, and as follows:

1. Weld Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**], nominal.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds [**18 inches (460 mm) apart, maximum**][**12 inches (300 mm) apart in Zone 1 and 6 inches (150 mm) apart in Zones 2 and 3, based on roof-area definitions in FM Global Loss Prevention Data Sheet 1-28**][**as indicated**].
3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or [**18 inches (460 mm)**][**36 inches (1 m)**], and as follows:

1. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches (38 mm)**, with end joints as follows:

1. End Joints: [**Lapped 2 inches (50 mm) minimum**][**Butted**][**Lapped 2 inches (50 mm) minimum or butted at Contractor's option**].

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and [**weld**][**mechanically fasten**] flanges to top of deck. Space [**welds**][**mechanical fasteners**] not more than **12 inches (300 mm)** apart with at least one [**weld**][**fastener**] at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and [**weld**][**or**][**mechanically fasten**].

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions.
[**Weld**][**or**][**mechanically fasten**] to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 INSTALLATION OF FLOOR DECK

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**], nominal.
2. Weld Spacing:

   a. Weld edge ribs of panels at each support. Space additional welds an average of **16 inches (400 mm)** apart, but not more than **18 inches (460 mm)** apart.
   b. Space and locate welds as indicated.

3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or **36 inches (1 m)**, and as follows:

1. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of [**1-1/2 inches (38 mm)**], with end joints as follows:

1. End Joints: [**Lapped**][**Butted**][**Lapped or butted at Contractor's option**].

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Electrified Cellular Floor Deck: Install cellular floor system with deck assembled from [**all-cellular units**][**alternating cellular units with noncellular composite units**][**units indicated**].

1. Coordinate layout and installation of trench headers, preset inserts, duct fittings, and other components specified in Section 260539 "Underfloor Raceways for Electrical Systems" with installation of electrified cellular metal floor deck.

G. Install piercing hanger tabs at [**14 inches (355 mm)**] apart in both directions, within **9 inches (228 mm)** of walls at ends, and not more than **12 inches (305 mm)** from walls at sides unless otherwise indicated.

3.5 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on [**both surfaces**][**top surface**] of prime-painted deck immediately after installation, and apply repair paint.
2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.

    a. Field welds will be subject to inspection.

2. Steel decking will be considered defective if it does not pass tests and inspections.
3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors that are already tested.

C. Prepare test and inspection reports.

END OF SECTION 05 31 00 00

Task	Specification	Specification Description
05 31 13 00	05 31 00 00	Steel Decking
05 31 23 00	05 31 00 00	Steel Decking
05 31 33 00	05 31 00 00	Steel Decking
05 36 00 00	05 31 00 00	Steel Decking

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SECTION 05 40 00 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-formed steel framing.
2. Load-bearing wall framing.
3. Exterior non-load-bearing wall framing.
4. Vertical deflection clips, exterior.
5. Interior non-load-bearing wall framing.
6. Vertical deflection clips, interior.
7. Floor joist framing.
8. Roof-rafter framing.
9. Soffit framing.
10. Sill sealer gasket/termite barrier.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, within height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
3. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For cold-formed steel framing, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

12. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

13. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

14. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List

Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

15. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For shop or field welding.

B. Product Certificates: For each type of code-compliance certification for studs and track.

C. Product Test Reports: For each listed product, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**] .

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

D. Research Reports:

1. For nonstandard cold-formed steel framing [**post-installed anchors**][**and**][**power-actuated fasteners**] , from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
2. For sill sealer gasket/termite barrier, showing compliance with ICC-ES AC380.

E. Qualification Statements: For testing agency.

F. Delegated Design Engineer Qualifications: For cold-formed steel framing.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by International Accreditation Service (IAS) to IAS AC98 criteria for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency [**, or in-house testing with calibrated test equipment,**] indicating steel sheet complies with requirements, including base-steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Track: Provide documentation that framing members are certified in accordance with the product-certification program of [**the Steel Framing Industry Association**][**the Steel Stud Manufacturers Association**][**the Supreme Steel Framing System Association**] .

D. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

E. Comply with AISI S230 for one- and two-family dwellings.

F. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: [**As indicated on Drawings**] .
2. Deflection Limits: Design framing systems to withstand [**design loads**] without deflections greater than the following:

    a. Load-Bearing Wall Framing:

        1) Exterior: Horizontal deflection of [**1/240**][**1/360**][**1/600**][**1/720**] of the wall height.
        2) Interior: Horizontal deflection of [**1/240**][**1/360**] of the wall height under a horizontal load of **5 lbf/sq. ft. (239 Pa)**.

    b. Exterior Non-Load-Bearing Wall Framing: Horizontal deflection of [**1/240**][**1/360**][**1/600**][**1/720**] of the wall height.
    c. Interior Non-Load-Bearing Wall Framing: Horizontal deflection of [**1/240**][**1/360**] of the wall height under a horizontal load of **5 lbf/sq. ft. (239 Pa)**.
    d. Floor Joist Framing: Vertical deflection of [**1/360**][**1/480**] for live loads and l/240 for total loads of the span.
    e. Roof-Rafter Framing: Vertical deflection of [**1/120**][**1/240**][**1/360**] of the horizontally projected span for live loads.
    f. Ceiling Joist Framing: Vertical deflection of [**1/120**][**1/240**][**1/360**] of the span for live loads and 1/240 for total loads of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of **120 deg F (67 deg C)**.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

    a. Upward and downward movement of [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch**

(25 mm)][1-1/2 inches (38 mm)] .

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and [**ASTM C955**][**AISI S200 and ASTM C955, Section 8**][**AISI S240**] .

D. Seismic Performance: Cold-formed steel framing to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7 and AISI S400**] .

E. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Product iQ" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

F. Sound-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, in accordance with ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 COLD-FORMED METAL FRAMING

A. Cold-Formed Steel Framing:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AllSteel & Gypsum Products, Inc.**]
b. [**CEMCO; California Expanded Metal Products Co.**]
c. [**ClarkDietrich**]
d. [**Consolidated Fabricators Corp.; Building Products Division**]
e. [**CRACO Mfg., Inc.**]
f. [**Design Shapes in Steel**]
g. [**Formetal Co. Inc. (The)**]
h. [**Jaimes Industries, Inc.**]
i. [**Marino\WARE**]
j. [**MBA Metal Framing**]
k. [**Mill Steel Framing; Mill Steel Company**]
l. [**MRI Steel Framing, LLC**]
m. [**Olmar Supply, Inc**]
n. [**Quail Run Building Materials, Inc.**]
o. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
p. [**State Building Products, Inc**]
q. [**Steel Construction Systems; Stone Group of Companies**]
r. [**Steel Network, Inc. (The)**]
s. [**Steeler, Inc**]
t. [**Super Stud Building Products Inc.**]
u. [**TELLING Industries**]
v. [**The Mill Steel Co**]
w. [**US Frame Factory**]

2. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of

preconsumer recycled content not less than 25 percent.

3. Framing Members, General: Comply with [**ASTM C955**][**AISI S200 and ASTM C955, Section 8**][**AISI S240**] for conditions indicated.
4. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

   a. Grade: [**ST33H (ST230H)**][**ST50H (ST340H)**][**As required by structural performance**] .

   b. Coating: [**G60 (Z180)**, **A60 (ZF180)**, **AZ50 (AZM150)**, **or GF30 (ZGF90)**][**G90 (Z275) or equivalent**] .

5. Steel Sheet for Vertical Deflection Drift Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

   a. Grade: [**33 (230)**][**50 (340)**, **Class 1**][**As required by structural performance**].
   b. Coating: **G90 (Z275)**.

2.3 LOAD-BEARING WALL FRAMING

A. Steel Studs, Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**] .

B. Steel Track, Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel studs**] .
2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**] .

C. Steel Box or Back-to-Back Headers, Load-Bearing Wall: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**] .

D. Steel Single- or Double-L Headers, Load-Bearing Wall: Manufacturer's standard L-shapes used to form header beams, of web depths indicated, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Top Flange Width: [**1-1/2 inches (38 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-

1/2 inches (63 mm)] .

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs, Exterior Non-Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**].

B. Steel Track, Exterior Non-Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel studs**] .
2. Flange Width: [**1-1/4 inches (32 mm)**].

C. Vertical Deflection Clips, Exterior: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AllSteel & Gypsum Products, Inc.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Marino\WARE**]
e. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
f. [**Simpson Strong-Tie Co., Inc.**]
g. [**Steel Construction Systems; Stone Group of Companies**]
h. [**Steel Network, Inc. (The)**]

2. Clip Type: [**Bypass**][**Head**].

D. Single Deflection Track, Exterior: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Steel Thickness: [**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].
2. Flange Width: [**1 inch (25 mm) plus the design gap for one-story structures**][**and**][**1 inch (25 mm) plus twice the design gap for other applications**].

E. Drift Clips, Exterior: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs, Interior Non-Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**] .

B. Steel Track, Interior Non-Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel studs**].
2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**] .

C. Vertical Deflection Clips, Interior: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AllSteel & Gypsum Products, Inc.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Marino\WARE**]
e. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
f. [**Simpson Strong-Tie Co., Inc.**]
g. [**Steeler, Inc**]

2. Clip Type: [**Bypass**][**Head**] .

D. Single Deflection Track, Interior: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Steel Thickness: [**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].
2. Flange Width: [**1 inch (25 mm) plus the design gap for one-story structures**][**and**][**1 inch (25 mm) plus twice the design gap for other applications**].

E. Drift Clips, Interior: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 FLOOR JOIST FRAMING

A. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, [**unpunched**][**punched with standard holes**][**punched with enlarged service holes**] with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

B. Steel Rim Joist Track: Manufacturer's standard U-shaped steel rim joist track, of web depths indicated, unpunched or punched at joist spacing, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel joists**].

2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**], minimum.

2.7 ROOF-RAFTER FRAMING

A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

2.8 SOFFIT FRAMING

A. Exterior Soffit Framing: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

2.9 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic-coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.

2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.10 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process in accordance with ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, [**Grade 36**][**Grade 55**] , threaded carbon steel bolts, carbon-steel nuts, and flat, hardened-steel washers.

1. Bolt Type: [**Hex-headed bolts**][**Headless, hooked bolts**][**Headless bolts, with encased end threaded**]
2. Zinc Coating: [**Hot-dip process in accordance with ASTM A153/A153M, Class C**][**Mechanically deposition according to ASTM B695, Class 50**] .

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction.

1. Acceptance Criteria: [**ICC-ES AC01**][**ICC-ES AC193**][**ICC-ES AC58**][**ICC-ES AC308**] as appropriate for the substrate
2. Uses: Securing cold-formed steel framing to structure.
3. Type: [**Torque-controlled expansion anchor**][**Torque-controlled adhesive anchor**][**adhesive anchor**] .
4. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.
5. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ISO 3506-1)**.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.11 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: [**ASTM A780/A780M**][**MIL-P-21035B**][**SSPC-Paint 20**] .

B. Cement Grout: Portland cement, ASTM C476, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sill Sealer Gasket: Closed-cell neoprene foam, **1/4 inch (6 mm)** thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

F. Sill Sealer Gasket/Termite Barrier: Minimum **68-mil (1.7-mm)** nominal thickness, self-adhering sheet consisting of **64 mils (1.6 mm)** of rubberized asphalt laminated on one side to a **4-mil- (0.10-mm-)** thick, polyethylene-film reinforcement, and with release liner on adhesive side [**; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Polyguard Products, Inc.**]

2. Physical Properties:

   a. Peel Adhesion: **17.0 lb/in (2.9 N/mm)** of width when tested in accordance with ASTM D412.
   b. Low-Temperature Flexibility: Pass at **minus 25 deg F (minus 32 deg C)** when tested in accordance with ASTM D146/D146M.
   c. Water Vapor Permeance: **0.05 perm (0.44 ng/Pa x s x sq. m)** maximum when tested in accordance with ASTM E96/E96M, Method B.
   d. Resistance to Termite Penetration: Comply with ICC-ES AC380.

2.12 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, in accordance with AISI S240 and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners and install in accordance with Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, in accordance with Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of **1/8 inch in 10 ft. (1:960)** and as follows:

1. Spacing: Space individual framing members no more than plus or minus **1/8 inch (3 mm)** from plan location. Cumulative errors are not to exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of **1/8 inch (3 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or track to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than **1/4 inch (6 mm)** to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Sill Sealer Gasket: Install at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

E. Sill Sealer Gasket/Termite Barrier: Install in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION OF COLD-FORMED STEEL FRAMING

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing in accordance with ASTM C1007, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding **1/16 inch (1.6 mm)**.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners, install in accordance with Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF LOAD-BEARING WALL FRAMING

A. Install continuous top and bottom track sized to match studs. Align track accurately and securely anchor at corners and ends, and at spacings as follows:

1. Anchor Spacing: [**As indicated on Shop Drawings**].

B. Squarely seat studs against top and bottom track, with gap not exceeding **1/8 inch (3 mm)** between the end of wall-framing member and the web of track.

1. Fasten both flanges of studs to top and bottom track.
2. Space studs as follows:

a. Stud Spacing: [12 inches (305 mm)][16 inches (406 mm)][19.2 inches (488 mm)][24 inches (610 mm)][**As indicated on Shop Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs in accordance with AISI S240, Section C3.5.2. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
2. Install track and jack studs above and below wall openings. Anchor track to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically [48 inches (1220 mm)][**as indicated on Drawings**][**as indicated on Shop Drawings**]. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed in accordance with manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom track. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION OF EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Install continuous track sized to match studs. Align track accurately and securely anchor to supporting

structure.

B. Fastening of Studs: Fasten both flanges of studs to [**top and**] bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Shop Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Single Deflection Track, Exterior: Install and anchor to building structure.
2. Vertical Deflection Clips, Exterior: Connect to [**bypassing**][**infill**] studs and anchor to building structure.
3. Drift Clips, Exterior: Connect to cold-formed steel framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated [**on Shop Drawings**] but not more than **48 inches (1220 mm)** apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel U-channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within [**12 inches (305 mm)**][**18 inches (450 mm)**] of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at [**96-inch (2440-mm) centers**][**centers indicated**][**centers indicated on Shop Drawings**] .

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INSTALLATION OF INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Install continuous track sized to match studs. Align track accurately and securely anchor to supporting structure.

B. Fastening of Studs: Fasten both flanges of studs to [**top and**] bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while

providing lateral support.

1. Single Deflection Track, Interior: Install and anchor to building structure.
2. Vertical Deflection Clips, Interior: Connect to studs and anchor to building structure.
3. Drift Clips, Interior: Connect to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated [**on Shop Drawings**] but not more than **48 inches (1220 mm)** apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within [**12 inches (305 mm)**][**18 inches (450 mm)**] of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at [**96-inch (2440-mm) centers**][**centers indicated**][**centers indicated on Shop Drawings**] .

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.7 INSTALLATION OF FLOOR JOIST FRAMING

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated [**on Shop Drawings**] .

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing as indicated on Shop Drawings.
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Space joists not more than **2 inches (51 mm)** from abutting walls, and as follows:

1. Joist Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Drawings**].

D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.

1. Install web stiffeners to transfer axial loads of walls above.

F. Bridging: Install bridging at intervals indicated [**on Shop Drawings**] . Fasten bridging at each joist intersection as follows:

1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.8 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of **1/8 inch in 10 ft. (1:960)** and as follows:

1. Space individual framing members no more than plus or minus **1/8 inch (3 mm)** from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.9 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Testing: the Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports, as directed by the Owner.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect, as directed by the Owner.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00 00

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Task	Specification	Specification Description
05 41 00 00	05 40 00 00	Cold-Formed Metal Framing
05 42 00 00	05 40 00 00	Cold-Formed Metal Framing
05 42 13 00	05 40 00 00	Cold-Formed Metal Framing
05 42 23 00	05 40 00 00	Cold-Formed Metal Framing
05 43 00 00	01 11 19 00	No Specification Required
05 43 00 00	05 40 00 00	Cold-Formed Metal Framing
05 43 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 44 00 00 - COLD-FORMED METAL TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-formed steel trusses.

B. Related Requirements:

1. Section 052100 "Steel Joist Framing" for standard, open-web steel joists and joist girders.
2. Section 054000 "Cold-Formed Metal Framing" for cold-formed steel studs, joists, and rafters.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel trusses; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated Design Submittals: For cold-formed steel trusses, including analysis data signed and sealed by the qualified professional responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: For each listed product, for tests performed by [**a qualified testing agency**] [**manufacturer and witnessed by a qualified testing agency**].

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Miscellaneous structural clips and accessories.

C. Research Reports: For [**post-installed anchors**] [**and**] [**power-actuated fasteners**], from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

D. Field Quality-Control Reports: For cold-formed steel trusses.

E. Qualification Statements: For [**fabricator**] [**Installer**] [**testing agency**].

F. Delegated Design Engineer Qualifications: For cold-formed steel trusses.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: [**Fabricator of products**] [**Entity that employs installers and supervisors who are trained and approved by manufacturer**] [**Authorized representative who is trained and approved by manufacturer**].

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency Qualifications: Accredited by International Accreditation Service (IAS) to IAS- AC98 criteria for testing indicated.

D. Product Tests: Mill certificates or data from a qualified independent testing agency [**or in-house testing with calibrated test equipment,**] indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

E. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel trusses.

B. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: [**As indicated on Drawings**].
2. Deflection Limits: Design trusses to withstand design loads without deflections greater than the following:

a. Floor Trusses: Vertical deflection of 1/480 for live loads and l/360 for total loads of the span.
b. Roof Trusses: Vertical deflection of [**1/240**] [**1/360**] of the span.
c. Scissor Roof Trusses: Horizontal deflection of [**1-1/4 inches (32 mm)**] at reactions.

3. Design trusses to provide for movement of truss members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).

C. Seismic Performance: Cold-formed steel trusses to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7 and AISI S400**].

D. Cold-Formed Steel Truss Standards: Unless more stringent requirements are indicated, trusses comply with AISI S100 and [**ASTM C955**] [**AISI S200 and ASTM C955, Section 8**] [**AISI S240**].

E. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Product iQ" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

F. Sound-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

2.2 COLD-FORMED STEEL TRUSSES

A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: [**ST33H (ST230H)**] [**ST50H (ST340H)**] [**As required by structural performance**] .
2. Coating: [**G60 (Z180)**, **A60 (ZF180)**, **AZ50 (AZ150)**, **or GF30 (ZGF90)**] [**G90 (Z275) or equivalent**] .

2.3 COLD-FORMED STEEL ROOF TRUSSES

A. Roof Truss Members: Manufacturer's standard [**C-shaped**]steel sections.

1. Connecting Flange Width: [**1-5/8 inches (41 mm)**], minimum at top and bottom chords connecting to sheathing or other directly fastened construction.
2. Minimum Base-Metal Thickness: [**0.0329 inch (0.84 mm)**] [**0.0428 inch (1.09 mm)**] [**0.0538 inch (1.37 mm)**] [**0.0677 inch (1.72 mm)**] [**0.0966 inch (2.45 mm)**].

2.4 COLD-FORMED STEEL FLOOR TRUSSES

A. Floor Truss Members: Manufacturer's standard [**C-shaped**]steel sections.

1. Connecting Flange Width: [**1-5/8 inches (41 mm)**], minimum at top and bottom chords connecting to sheathing or other directly fastened construction.
2. Minimum Base-Metal Thickness: [**0.0329 inch (0.84 mm)**] [**0.0428 inch (1.09 mm)**] [**0.0538 inch (1.37 mm)**] [**0.0677 inch (1.72 mm)**] [**0.0966 inch (2.45 mm)**].

2.5 TRUSS ACCESSORIES

A. Fabricate steel-truss accessories from steel sheet, ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for truss members.

B. Provide accessories of manufacturer's standard thickness and configuration unless otherwise indicated.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process in accordance with ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, [**Grade 36**] [**Grade 55**], threaded carbon-steel [**hex-headed bolts,**] [**headless, hooked bolts,**] [**headless bolts, with encased end threaded,**] carbon-steel nuts, and flat, hardened-steel washers; zinc coated by [**hot-dip process in accordance with ASTM A153/A153M, Class C**] [**mechanical deposition in accordance with ASTM B695, Class 50**].

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on [**ICC-ES AC01**] [**ICC-ES AC193**] [**ICC-ES AC58**] [**or**] [**ICC-ES AC308**] as appropriate for the substrate.

1. Uses: Securing cold-formed steel trusses to structure.
2. Type: [**Torque-controlled expansion anchor**] [**Torque-controlled adhesive anchor**] [**or**] [**adhesive anchor**].
3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**] [**Group 2 (A4)**] stainless steel bolts, ASTM F593 (ISO 3506-1), and nuts, ASTM F594 (ASTM F836M).

D. Power-Actuated Fasteners: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: [**ASTM A780/A780M**] [**MIL-P-21035B**] [**or**] [**SSPC-Paint 20**].

B. Shims: Load-bearing, high-density multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as truss members supported by shims.

2.8 FABRICATION OF COLD-FORMED STEEL TRUSSES AND ACCESSORIES

A. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, in accordance with referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate trusses using jigs or templates.
2. Cut truss members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

4. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, in accordance with Shop Drawings.

B. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 ft. (1:960) and as follows:

1. Spacing: Space individual truss members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative errors are not to exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel truss to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting trusses and framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed steel trusses without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION OF COLD-FORMED STEEL TRUSSES

A. Install bridge, and brace cold-formed steel trusses in accordance with AISI S200, AISI S202, AISI S214, and manufacturer's written instructions unless more stringent requirements are indicated.

1. Coordinate with wall framing to align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure.
2. Anchor trusses securely at all bearing points.
3. Install continuous bridging and permanently brace trusses[**as indicated on Drawings.**] [**as indicated on Shop Drawings and designed in accordance with CFSEI's Technical Note 551e, "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses."**][.]

B. Install cold-formed steel trusses and accessories true to line and location, and with connections securely fastened.

1. Erect trusses with plane of truss webs plumb and parallel to each other. Align and accurately position trusses at required spacings.
2. Erect trusses without damaging truss members or connections.
3. Fasten cold-formed steel trusses by welding or mechanical fasteners.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners, install in accordance with Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

C. Install temporary bracing and supports to secure trusses and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to trusses are secured.

D. Truss Spacing: [**16 inches (406 mm)**] [**19.2 inches (488 mm)**] [**24 inches (610 mm)**] [**32 inches (813 mm)**] [**48 inches (1220 mm)**] [**As indicated on Drawings**].

E. Do not alter, cut, or remove truss members or connections of trusses.

3.4 ERECTION TOLERANCES

A. Install cold-formed steel trusses level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 ft. (1:960) and as follows:

1. Space individual trusses no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.5 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel trusses with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**] [**Engage**] a qualified special inspector to perform the following special inspections:

1. Cold-Formed Steel Trusses Spanning 60 Ft. (18 288 mm) or Longer: Verify temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

B. Testing Agency: [**the Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

C. Cold-formed metal trusses will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel trusses are without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 44 00 00

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Task	Specification	Specification Description
05 44 00 00	05 40 00 00	Cold-Formed Metal Framing
05 44 13 00	05 40 00 00	Cold-Formed Metal Framing
05 44 13 00	05 44 00 00	Cold-Formed Metal Trusses

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SECTION 05 50 00 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Prefabricated building columns.
3. Shelf angles.
4. Metal ladders.
5. Alternating tread devices.
6. Metal ships' ladders and pipe crossovers.
7. Metal floor plate.
8. Elevator pit sump covers.
9. Structural-steel door frames.
10. Miscellaneous steel trim.
11. Metal bollards.
12. Vehicular barrier cable systems.
13. Pipe and downspout guards.
14. Abrasive metal nosings, treads, and thresholds.
15. Cast-iron wheel guards.
16. Metal downspout boots.
17. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
3. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Requirements:

1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
3. Section 077200 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Fasteners.
3. Shop primers.
4. Shrinkage-resisting grout.
5. Prefabricated building columns.
6. Slotted channel framing.
7. Manufactured metal ladders.
8. Alternating tread devices.
9. Metal ships' ladders and pipe crossovers.
10. Metal bollards.
11. Vehicular barrier cable systems.
12. Pipe and downspout guards.
13. Abrasive metal nosings, treads, and thresholds.
14. Cast-iron wheel guards.
15. Metal downspout boots.

B. Shop Drawings: Show fabrication and installation details.[**Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.**] Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
2. Elevator machine beams, hoist beams, and divider beams.
3. Steel shapes for supporting elevator door sills.
4. Steel girders for supporting wood frame construction.
5. Steel pipe columns for supporting wood frame construction.
6. Prefabricated building columns.
7. Shelf angles.
8. Metal ladders.
9. Alternating tread devices.
10. Metal ships' ladders and pipe crossovers.
11. Metal floor plate and supports.
12. Elevator pit sump covers.
13. Structural-steel door frames.
14. Miscellaneous steel trim including [**steel angle corner guards**][**steel edgings**][**and**][**loading-dock edge angles**].
15. Metal bollards.
16. Loose steel lintels.
17. Vehicular barrier cable systems.

C. Samples for Verification: For each type and finish of extruded [**nosing**][**and**][**tread**].

D. Delegated Design Submittals: For [**ladders**][**alternating tread devices**][**and**][**vehicular barrier cable systems**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.
12. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
13. Health Product Declaration (HPD): For each product.
14. Health Product Declaration (HPD): Provide HPD.
15. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.4 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research Reports: For post-installed anchors.

E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**ladders**][**alternating tread devices**][**and**][**vehicular barrier cable systems**].

B. Structural Performance of Aluminum Ladders: Ladders[**, including landings,**] are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.

C. Structural Performance of Alternating Tread Devices: Alternating tread devices are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Comply with applicable railing loadings in Section 055213 "Pipe and Tube Railings."

D. Vehicular Barrier Cable Systems: Design vehicular barrier cable systems to resist a single [**6000-lbf (28.7-kN)**] service load and [**10,000-lbf (47.9-kN)**] ultimate load applied horizontally in any direction to the cable system, with anchorages or attachments capable of transferring this load to the structure. Limit deflection to **18 inches (457 mm)**. Design is to assume loads are applied at a height of [**18 inches (457 mm)**] above the floor or ramp surface on an area not to exceed **1 sq. ft. (0.09 sq. m)**.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles**

(800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

I. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**].

J. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

K. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

L. Rolled-Stainless Steel Floor Plate: ASTM A793.

M. Abrasive-Surface Floor Plate: Steel plate [**with abrasive granules rolled into surface**][**or**][**with abrasive material metallically bonded to steel**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**IKG**]
b. [**Ohio Gratings, Inc**]
c. [**SlipNOT Metal Safety Flooring, division of Traction Technologies Holdings, LLC**]

2. Source Limitations: Obtain floor plate from single source from single manufacturer.

N. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

O. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

P. Zinc-Coated Steel Wire Rope: ASTM A741.

1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

Q. Stainless Steel Wire Rope: Wire rope manufactured from stainless steel wire complying with ASTM A492, Type 316.

1. Wire Rope Fittings: Stainless steel connectors, Type 316, with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

R. Steel Prestressing Strand: ASTM A416/A416M, Grade 270 (Grade 1860), low-relaxation, seven-wire, with 0.9-lb/sq. ft. (4.39-kg/sq. m) zinc coating.

1. Steel Prestressing Strand Fittings: Hot-dip galvanized-steel anchors and connectors with capability to sustain, without failure, a load equal to minimum breaking strength of steel prestressing strand with which they are used.

S. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: [**1-5/8 by 1-5/8 inches (41 by 41 mm)**][**As indicated**].
2. Galvanized Steel: ASTM A653/A653M, [**commercial steel, Type B**][**structural steel, Grade 33 (Grade 230)**], with **G90 (Z275)** coating; [**0.108-inch (2.8-mm)**][**0.079-inch (2-mm)**][**0.064-inch (1.6-mm)**] nominal thickness.
3. Cold-Rolled Steel: ASTM A1008/A1008M, [**commercial steel, Type B**][**structural steel, Grade 33 (Grade 230)**]; [**0.0966-inch (2.5-mm)**][**0.0677-inch (1.7-mm)**][**0.0528-inch (1.35-mm)**] minimum thickness; [**unfinished**][**coated with rust-inhibitive, baked-on, acrylic enamel**][**hot-dip galvanized after fabrication**].

T. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

U. Aluminum Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.

V. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.

W. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

X. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

Y. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

Z. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).

AA. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.

BB. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening [**aluminum**][**stainless steel**][**or**][**nickel silver**].
2. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 3, heavy-hex steel structural bolts; **ASTM A563, Grade DH3, (ASTM A563M, Class 10S3)** heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, **ASTM F593 (ISO 3506-1)**; with hex nuts, **ASTM F594 (ASTM F836M)**; and, where indicated, flat washers; Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

H. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, **1-5/8 by 7/8 inches (41 by 22 mm)** by length indicated with anchor straps or studs not less than **3 inches (75 mm)** long at not more than **8 inches (200 mm)** o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of **3000 psi (20 MPa)**.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing[**and contour of welded surface matches that of adjacent surface**].

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, **1/8 by 1-1/2 inches (3.2 by 38 mm)**, with a minimum **6-inch (150-mm)** embedment and **2-inch (50-mm)** hook, not less than **8 inches (200 mm)** from ends and corners of units and **24 inches (600 mm)** o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated.

Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes [**indicated**][**recommended by partition manufacturer**] with attached bearing plates, anchors, and braces as [**indicated**][**recommended by partition manufacturer**]. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Provide bearing plates welded to beams where indicated.
2. Drill or punch girders and plates for field-bolted connections where indicated.
3. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at **24 inches (600 mm)** o.c.

E. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
2. Unless otherwise indicated, provide **1/2-inch (12.7-mm)** baseplates with four **5/8-inch (16-mm)** anchor bolts and **1/4-inch (6.4-mm)** top plates.

F. Galvanize miscellaneous framing and supports where indicated.

G. Prime miscellaneous framing and supports with [**zinc-rich primer**][**primer specified in Section 099600 "High-Performance Coatings"**] where indicated.

2.7 PREFABRICATED BUILDING COLUMNS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Black Rock Fireproof Column, a division of United Steel**]
2. [**Dean Lally LLC / FireTrol Columns**]

B. Source Limitations: Obtain prefabricated building column from single source from single manufacturer.

C. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.

D. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

1. Fire-Resistance Rating: [**4 hours**][**3 hours**][**2 hours**][**As indicated**].

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive **3/4-inch (19-mm)** bolts, spaced not more than **6 inches (150 mm)** from ends and **24 inches (600 mm)** o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately **2 inches (50 mm)** larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize[**and prime**] shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 METAL LADDERS

A. General:

1. Comply with ANSI A14.3[**, except for elevator pit ladders**].
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails [**16 inches (406 mm)**][**18 inches (457 mm)**] apart unless otherwise indicated.
2. Siderails: Continuous, [**3/8-by-2-1/2-inch (9.5-by-64-mm)**][**1/2-by-2-1/2-inch (12.7-by-64-mm)**] steel flat bars, with eased edges.
3. Rungs: [**3/4-inch- (19-mm-) diameter**][**3/4-inch- (19-mm-) square**][**1-inch- (25-mm-) diameter**][**1-inch- (25-mm-) square**], steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Nonslip Surfaces for Steel Ladders: Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**IKG**]
        2) [**SlipNOT Metal Safety Flooring, division of Traction Technologies Holdings, LLC**]

7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating,

supported by steel angles. Limit openings in gratings to no more than [1/2 inch (12 mm)][3/4 inch (19 mm)] in least dimension.

9. Support each ladder[**at top and bottom and not more than 60 inches (1500 mm) o.c.**] with welded or bolted steel brackets.
10. Galvanize[**and prime**][**exterior**]ladders, including brackets.
11. Prime [**exterior**]ladders, including brackets and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

C. Aluminum Ladders:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Halliday Products**]
    b. [**Kattsafe**]
    c. [**O'Keeffe's Inc.**]
    d. [**Precision Ladders, LLC**]
    e. [**Royalite Manufacturing, Inc.**]
    f. [**Thompson Fabricating, LLC**]
    g. [**UPNOVR, Inc.**]

2. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.
3. Space siderails [16 inches (406 mm)][18 inches (457 mm)] apart unless otherwise indicated.
4. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
5. Rungs: Extruded-aluminum tubes, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, with ribbed tread surfaces.
6. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
7. Provide platforms as indicated fabricated from [**pressure-locked aluminum bar grating**][**or**][**extruded-aluminum plank grating**], supported by extruded-aluminum framing. Limit openings in gratings to no more than [1/2 inch (12 mm)][3/4 inch (19 mm)] in least dimension.
8. Support each ladder[**at top and bottom and not more than 60 inches (1500 mm) o.c.**] with welded or bolted aluminum brackets.
9. Provide minimum 72-inch- (1830-mm-) high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.10 ALTERNATING TREAD DEVICES

A. Alternating Tread Devices: Fabricate alternating tread devices of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Lapeyre Stair Inc.**]
    b. [**Precision Ladders, LLC**]

2. Tread depth is not to be less than **5 inches (127 mm)** exclusive of nosing or less than **8-1/2 inches (216 mm)**, including the nosing, tread width is not to be less than **7 inches (178 mm)**, and riser height is not to be more than **9-1/2 inches (241 mm)**.
3. Tread depth is not to be less than **8-1/2 inches (216 mm)** exclusive of nosing or less than **10-1/2 inches (267 mm)**, including the nosing, tread width is not to be less than **7 inches (178 mm)**, and riser height is not to be more than **8 inches (203 mm)**.
4. Fabricate from [**steel**][**stainless steel**][**aluminum**] and assemble by welding or with stainless steel fasteners.
5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."

B. Galvanize[**and prime**][**exterior**]steel alternating tread devices, including treads, railings, brackets, and fasteners.

C. Prime [**exterior**]steel alternating tread devices, including treads, railings, brackets, and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.11 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Provide metal [**ships' ladders**][**and**][**pipe crossovers**] where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Treads are not to be less than **5 inches (127 mm)** exclusive of nosing or less than **8-1/2 inches (216 mm)** including the nosing, and riser height is not to be more than **9-1/2 inches (241 mm)**.
2. Fabricate [**ships' ladders**][**and**][**pipe crossovers**], including railings from [**steel**][**stainless steel**][**aluminum**].
3. Fabricate treads[**and platforms**] from [**welded or pressure-locked steel bar**][**pressure-locked stainless steel bar**][**pressure-locked aluminum bar**][**extruded-aluminum plank**] grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**] in least dimension.
4. Fabricate treads[**and platforms**] from [**rolled-steel floor**][**rolled-stainless steel floor**][**rolled-aluminum-alloy tread**][**abrasive-surface floor**] plate.
5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."

B. Galvanize[**and prime**][**exterior**]steel [**ships' ladders**][**and**][**pipe crossovers**], including treads, railings, brackets, and fasteners.

C. Prime [**exterior**]steel [**ships' ladders**][**and**][**pipe crossovers**], including treads, railings, brackets, and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.12 METAL FLOOR PLATE

A. Fabricate from [**rolled-steel floor**][**rolled-stainless steel floor**][**rolled-aluminum-alloy tread**][**abrasive-surface floor**] plate of thickness indicated below:

1. Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**5/16 inch (8 mm)**][**3/8 inch (9.5 mm)**][**As indicated**].

B. Provide grating sections where indicated, fabricated from [**welded or pressure-locked steel bar**][**pressure-locked stainless steel bar**][**pressure-locked aluminum bar**][**extruded-aluminum plank**] grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] in least dimension.

C. Provide [**steel**][**stainless steel**][**aluminum**] angle supports as indicated.

D. Include [**steel**][**stainless steel**][**aluminum**] angle stiffeners, and fixed and removable sections as indicated.

E. Provide flush [**steel**][**stainless steel**][**aluminum**] bar drop handles for lifting removable sections, one at each end of each section.

2.13 ELEVATOR PIT SUMP COVERS

A. Fabricate from [**1/8-inch (3.2-mm)**][**3/16-inch (4.8-mm)**][**rolled-steel**][**abrasive-surface**] floor plate with four **1-inch- (25-mm-)** diameter holes for water drainage and for lifting.

B. Fabricate from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] in least dimension.

C. Provide steel angle supports unless otherwise indicated.

2.14 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with **5/8-by-1-1/2-inch (16-by-38-mm)** steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than **10 inches (250 mm)** o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Galvanize[**and prime**][**exterior**]steel frames.

D. Prime [**exterior**]steel frames with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.15 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize[**and prime**][**exterior**]miscellaneous steel trim.

D. Prime [**exterior**]miscellaneous steel trim with [**zinc-rich primer.**][**primer specified in Section 099600**

"High-Performance Coatings."]

2.16 METAL BOLLARDS

A. Fabricate metal bollards from [**Schedule 80 steel pipe**][**Schedule 40 steel pipe**][**Schedule 80 stainless steel, No. 4/180-grit finish**][**1/4-inch (6.4-mm) wall-thickness rectangular steel tubing**][**steel shapes, as indicated**].

1. Cap bollards with **1/4-inch- (6.4-mm-)** thick, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] plate with [**flat**][**sloped**][**domed**] top.
2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Fabricate bollards with **3/8-inch- (9.5-mm-)** thick, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] baseplates for bolting to concrete slab. Drill baseplates at all four corners for **3/4-inch (19-mm)** anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Fabricate sleeves for bollard anchorage from steel or stainless steel [**pipe**][**or**][**tubing**] with **1/4-inch- (6.4-mm-)** thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than **8 inches (200 mm)** deep and **3/4 inch (19 mm)** larger than OD of bollard.

D. Fabricate internal sleeves for removable bollards from Schedule 80 [**steel**][**stainless steel**] pipe or **1/4-inch (6.4-mm)** wall-thickness [**steel**][**stainless steel**] tubing with an OD approximately **1/16 inch (1.5 mm)** less than ID of bollards. Match drill sleeve and bollard for **3/4-inch (19-mm)** [**steel**][**stainless steel**] machine bolt.

E. Prime steel bollards with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.17 VEHICULAR BARRIER CABLE SYSTEMS

A. Vehicular Barrier Cable Systems: Of diameter required by performance requirements, but not less than **1/2-inch- (12-mm-)** diameter, [**zinc-coated steel wire rope**][**stainless steel wire rope**][**zinc-coated steel prestressing strand**] with turnbuckles, toggles, machine swage terminals, and other fittings and accessories for securing to structural columns and walls and for tightening barrier cable.

2.18 PIPE AND DOWNSPOUT GUARDS

A. Fabricate [**pipe**][**downspout**] guards from **3/8-inch- (9.5-mm-)** thick by **12-inch- (300-mm-)** wide, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] plate, bent to fit flat against the wall or column at both ends and to fit around pipe with **2-inch (50-mm)** clearance between pipe and pipe guard. Drill each end for two **3/4-inch (19-mm)** anchor bolts.

B. Galvanize[**and prime**] steel [**pipe**][**downspout**] guards.

C. Prime steel [**pipe**][**downspout**] guards with [**zinc-rich primer.**][**primer specified in Section 099600**

"High-Performance Coatings."]

2.19 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

A. Cast-Metal Units: Cast [**iron**][**aluminum**][**bronze (leaded red or semired brass)**][**nickel silver (leaded nickel bronze)**], with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Safety Tread Co., Inc**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Barry Pattern & Foundry Co., Inc**]
    d. [**Safe-T-Metal Company, Inc.**]
    e. [**Wooster Products Inc**]

2. Source Limitations: Obtain units from single source from single manufacturer.
3. Cross-hatched nosings, **4 inches (100 mm)** wide, with **1/4-inch- (6-mm-)** thick **1-inch (25-mm)** lip, for casting into concrete.
4. Cross-hatched nosings, **1-1/2 inches (38-mm)** wide, **3/8-inch- (9.5-mm-)** thick **1-1/2 inch (38-mm)** lip, for casting into concrete.
5. Cross-hatched Treads: Full depth of tread with **3/4-by-3/4-inch (19-by-19-mm)** nosing, for application over bent plate treads or existing stairs.
6. Fluted-Saddle-Type Thresholds: **5 inches (125 mm)** wide by **1/2 inch (12 mm)** high, with tapered edges.
7. Fluted-Interlocking or -Hook-Strip Thresholds: **5 inches (125 mm)** wide by **5/8 inch (16 mm)** high, with tapered edge.
8. Thresholds: Plain-stepped- (stop-) type units, **5 inches (125 mm)** wide by **1/2 inch (12 mm)** high, with **1/2-inch (12-mm)** step.

B. Extruded Units: [**Aluminum**][**Bronze**], with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Safety Tread Co., Inc**]
    b. [**Amstep Products**]
    c. [**Armstrong Products, Inc**]
    d. [**Balco; a CSW Industrials Company**]
    e. [**Nystrom, Inc.**]
    f. [**Wooster Products Inc**]

2. Source Limitations: Obtain units from single source from single manufacturer.
3. Provide ribbed units, with abrasive filler strips projecting **1/16 inch (1.5 mm)** above aluminum extrusion.
4. Provide solid-abrasive-type units without ribs.

5. Nosings:

   a. Square-back units, [1-7/8 inches (48 mm)][3 inches (75 mm)][4 inches (100 mm)] wide, for casting into concrete steps.
   b. Beveled-back units, [3 inches (75 mm)][4 inches (100 mm)] wide with 1-3/8-inch (35-mm) lip, for surface mounting on existing stairs.
   c. Two-piece units, 3 inches (75 mm) wide, with subchannel for casting into concrete steps.

6. Treads: [**Square**][**Beveled**]-back units, full depth of tread with 1-3/8-inch (35-mm) lip, for application over existing stairs.

C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

D. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.

1. Provide two rows of holes for units more than 5 inches (125 mm) wide, with two holes aligned at ends and intermediate holes staggered.

E. Apply bituminous paint to concealed surfaces of cast-metal units.

F. Apply clear lacquer to concealed surfaces of extruded units.

2.20 CAST-IRON WHEEL GUARDS

A. Provide wheel guards made from cast-iron, 3/4-inch- (19-mm-) thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.

B. Prime cast-iron wheel guards with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.21 METAL DOWNSPOUT BOOTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**J.R. Hoe & Sons Inc.**]
2. [**Neenah Foundry Company**]

B. Source Limitations: Obtain downspout boots from single source from single manufacturer.

C. Provide downspout boots made from cast [**iron**][**aluminum**] in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.

1. Outlet: [**Vertical, to discharge into pipe**][**Horizontal, to discharge into pipe**][**At 35 degrees from horizontal, to discharge onto splash block or pavement**].

D. Prime cast-iron downspout boots with [**zinc-rich primer.**][**primer specified in Section 099600 "High-**

Performance Coatings."]

2.22 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize bearing and leveling plates.

C. Prime plates with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.23 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than **8 inches (200 mm)** unless otherwise indicated.

C. Galvanize[**and prime**] loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.24 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.25 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.26 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items[**not indicated to be galvanized**] unless they are to be embedded in

concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting"**][**primers specified in Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 3, "Power Tool Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.27 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for [**ceiling-hung toilet partitions**][**operable partitions**][**overhead doors**][**and**][**overhead grilles**] securely to, and rigidly brace from, building structure.

C. Anchor shelf angles securely to existing construction with [**expansion anchors**][**anchor bolts**][**through bolts**].

D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

E. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.

3.4 INSTALLATION OF SHELF ANGLES

A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

3.5 INSTALLATION OF METAL LADDERS

A. Secure ladders to adjacent construction with the clip angles attached to the stringer.

B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.6 INSTALLATION OF ALTERNATING TREAD DEVICES

A. Secure top and bottom of alternating tread devices to construction to comply with manufacturer's written instructions.

3.7 INSTALLATION OF METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Secure top and bottom of ships' ladders to construction to comply with manufacturer's written instructions.

B. Secure pipe crossovers to construction to comply with manufacturer's written instructions.

3.8 INSTALLATION OF METAL FLOOR PLATE

A. Install metal floor plates flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.9 INSTALLATION OF ELEVATOR PIT SUMP COVERS

A. Install tops of elevator sump pit cover plates and frames flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.10 INSTALLATION OF STRUCTURAL-STEEL DOOR FRAMES

A. Fasten structural steel door frames to the floor slab by means of angle clips and expansion bolts. Anchor door jambs to adjacent construction in accordance with shop drawing details.

3.11 INSTALLATION OF MISCELLANEOUS STEEL TRIM

A. Anchor to concrete construction to comply with manufacturer's written instructions.

3.12 INSTALLATION OF METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

1. Do not fill removable bollards with concrete.

B. Anchor bollards to existing construction with [**expansion anchors**][**anchor bolts**][**through bolts**]. Provide four **3/4-inch (19-mm)** bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least **4 inches (100 mm)** in concrete.

C. Anchor bollards in concrete [**with pipe sleeves preset and anchored into concrete**][**in formed or core-drilled holes not less than 42 inches (1050 mm) deep and 3/4 inch (19 mm) larger than OD of bollard**]. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward bollard.

D. Anchor bollards in place with concrete footings. Center and align bollards in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

E. Anchor internal sleeves for removable bollards in [**concrete by inserting in pipe sleeves preset into concrete**][**formed or core-drilled holes not less than 42 inches (1050 mm) deep and 3/4 inch (19 mm) larger than OD of sleeve**]. Fill annular space around internal sleeves solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward internal sleeve.

F. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.

G. Place removable bollards over internal sleeves and secure with **3/4-inch (19-mm)** machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. The Owner furnishes padlocks.

H. Fill bollards solidly with concrete, mounding top surface to shed water.

1. Do not fill removable bollards with concrete.

3.13 INSTALLATION OF VEHICULAR BARRIER CABLE SYSTEMS

A. Install vehicular barrier cable systems at locations indicated, mounted at heights indicated on Drawings above the parking surface. Anchor [**wire ropes**][**steel prestressing strand**] to structural columns and walls and tension to withstand vehicle loading as specified in "Performance Requirements" Article with no cable tensioned less than **3000 lbf (13.3 kN)**. Do not displace supporting components.

3.14 INSTALLATION OF PIPE AND DOWNSPOUT GUARDS

A. Provide pipe guards at exposed vertical pipes in [**parking garage**][**at locations indicated on Drawings**] where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four **3/4-inch (19-mm)** bolts at each pipe guard. Mount pipe guards with top edge **26 inches (660 mm)** above driving surface.

3.15 INSTALLATION OF ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.16 INSTALLATION OF CAST-IRON WHEEL GUARDS

A. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

3.17 INSTALLATION OF METAL DOWNSPOUT BOOTS

A. Anchor metal downspout boots to concrete or masonry construction to comply with manufacturer's written instructions.

B. Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.

3.18 INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.19 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**]

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 50 00 00

SECTION 05 51 13 00 - METAL PAN STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with [**concrete-filled**][**precast concrete**][**precast terrazzo**][**epoxy-resin-filled**][**and**][**abrasive-coating-finished, formed-metal**] treads.
2. [**Steel tube**]railings and guards attached to metal stairs.
3. [**Steel tube**]handrails attached to walls adjacent to metal stairs.
4. Railing gates at the level of exit discharge.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs[**, railings, and guards**].

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts,[**blocking for attachment of wall-mounted handrails,**] and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.

D. Schedule installation of railings and guards so wall attachments are made only to completed walls.

1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:

1. Perforated metal.
2. Woven-wire mesh.
3. Welded-wire mesh.
4. Prefilled metal-pan-stair treads.
5. Abrasive nosings.
6. Shop primer products.
7. Nonslip-aggregate concrete finish.
8. Abrasive-coating finish to formed-metal stairs.
9. Precast concrete treads.
10. Precast terrazzo treads.
11. Epoxy-resin-filled stair treads.

12. Handrail wall brackets.
13. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.
5. Indicate profile and dimensions of precast terrazzo treads.
6. Indicate profile and dimensions of epoxy-resin-filled treads.

D. Samples for Verification: For each type and finish of [**nosing**][**precast terrazzo tread**][**epoxy-resin-filled tread**].

E. Delegated Design Submittal: For stairs, [**railings and guards,**][**precast terrazzo treads,**][**epoxy-resin-filled treads**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the [**jurisdiction**][**State**] in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, [**railings and guards,**][**precast terrazzo treads,**][**epoxy-resin-filled treads**], including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to [**L/360**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

a. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

D. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 METALS

A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Steel Tubing for Railings and Guards: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M**].

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Provide galvanized finish for exterior installations and where indicated.

D. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Provide galvanized finish for exterior installations and where indicated.

E. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M,[**either commercial steel, Type B, or**] structural steel, **Grade 25 (Grade 170)**, unless another grade is required by design loads; exposed.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M,[**either commercial steel, Type B, or**] structural steel, **Grade 30 (Grade 205)**, unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project

site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Galvanized Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating,[**either commercial steel, Type B, or**] structural steel, **Grade 33 (Grade 230)**, unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Expanded-Metal, Carbon Steel: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**], Class 1 (uncoated).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

7. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

I. Perforated Metal, Uncoated: Cold-rolled steel sheet, ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel Type B, [**0.060 inch (1.52 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**][**with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows**].

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

J. Perforated Metal, Galvanized Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, commercial steel Type B, [**0.064 inch (1.63 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

K. Perforated Metal, Aluminum Sheet: **ASTM B209 (ASTM B209M)**, [**0.125 inch (3.18 mm)**][**0.063 inch (1.60 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

L. Woven-Wire Mesh, Steel: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.135-inch (3.5-mm)** nominal-diameter steel wire complying with ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

M. Woven-Wire Mesh, Aluminum: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.162-inch- (4.1-mm-)** diameter, aluminum wire complying with **ASTM B211 (ASTM B211M)**, Alloy 6061-T94.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

N. Welded-Wire Mesh: [**Diamond**][**Square**] pattern, **2-inch (50-mm)** welded-wire mesh, made from **0.236-inch (6.0-mm)** nominal-diameter steel wire complying with ASTM A510/A510M.

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

O. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

P. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

Q. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

R. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

S. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

T. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.3 ABRASIVE NOSINGS

A. Cast-Metal Units: Cast [**iron**][**aluminum**][**bronze**][**nickel silver**], with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Safety Tread Co., Inc**]
b. [**Balco; a CSW Industrials Company**]
c. [**Barry Pattern & Foundry Co., Inc**]
d. [**Ecoglo, Inc.**]
e. [**Granite State Casting Co**]
f. [**Safe-T-Metal Company, Inc.**]

g. [**TrueNorth Steel**]
h. [**Wooster Products Inc**]

2. Configuration: Cross-hatched units, [**3 inches (75 mm)**][**4 inches (100 mm)**] wide without lip.

B. Extruded Units: [**Aluminum**][**Bronze**] units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Safety Tread Co., Inc**]
b. [**Amstep Products**]
c. [**Armstrong Products, Inc**]
d. [**Balco; a CSW Industrials Company**]
e. [**Ecoglo, Inc.**]
f. [**Granite State Casting Co**]
g. [**Nystrom, Inc.**]
h. [**UPNOVR, Inc.**]
i. [**Wooster Products Inc**]

2. Provide ribbed units, with abrasive filler strips projecting **1/16 inch (1.5 mm)** above aluminum extrusion.
3. Provide solid-abrasive units without ribs.
4. Nosings, Square-Back Units: [**1-7/8 inches (48 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] wide, without lip.
5. Nosings, Two-Piece Units: **3 inches (75 mm)** wide, with subchannel for casting into concrete.

C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

D. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

E. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.4 FASTENERS

A. General: Provide [**zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5**][**Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5**] where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated[**and capable of withstanding design loads**].

C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for [**exterior stairs**][**stairs indicated to be galvanized**][**stairs indicated to be shop primed with zinc-rich primer**].

E. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**] capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Handrail Wall Brackets: [**Cast nickel-silver,**][**Cast aluminum,**][**Cast bronze,**][**Cast stainless steel,**] center of rail [**2-1/2 inches (63.5 mm)**][**3-1/8 inches (79.4 mm)**] from face of wall.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Julius Blum & Co., Inc.**]
b. [**The Wagner Companies**]

B. Welding Electrodes: Comply with AWS requirements.

C. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

E. Zinc-Rich Primer: Comply with SSPC-Paint 20, [**Type I-A**][**Type I-B**][**Type I-C**][**Type II**], Level [**1**][**2**][**3**], and compatible with topcoat.

F. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish system indicated.

G. Galvanizing Repair Paint: High-zinc-dust-content paint complying with [**SSPC-Paint 20**][**ASTM A780/A780M**] and compatible with paints specified to be used over it.

H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

I. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for [**interior**][**exterior**] use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

J. Prefilled Concrete Treads:

1. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with minimum 28-day compressive strength of **3000 psi (20 MPa)** and maximum aggregate size of **1/2 inch (13 mm)** unless otherwise indicated.
2. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
3. Plain Steel Welded-Wire Reinforcement: ASTM A1064/A10645M, [**steel,**][**galvanized steel,**] **6 by 6 inches (152 by 152 mm)**, W1.4 by W1.4, unless otherwise indicated on Drawings.

    a. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

4. Reinforcement Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening welded-wire reinforcement in place.

    a. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete.

K. For galvanized reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.6 PRECAST CONCRETE TREADS

A. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of **5000 psi (35 MPa)** and a total air content of not less than 4 percent or more than 6 percent.

B. Reinforcement: Galvanized, welded-wire reinforcement, **2 by 2 inches (50 by 50 mm)** by **0.062-inch-(1.6-mm-)** diameter steel wire; comply with ASTM A1064/A1064M, except for minimum wire size.

2.7 PRECAST TERRAZZO TREADS

A. Precast Terrazzo Stair Treads: Epoxy terrazzo units cast in maximum lengths possible. Comply with manufacturer's written instructions for fabricating precast terrazzo units in sizes and profiles indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Wausau Tile, Inc.**]

2. Epoxy Resin Matrix: Manufacturer's standard recommended for use indicated.
3. Aggregates: Comply with NTMA gradation standards for mix indicated, and containing no deleterious or foreign matter.

a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
b. 24-Hour Absorption Rate: Less than 0.75 percent.
c. Dust Content: Less than 1.0 percent by weight.

4. Reinforcement: ASTM A615/A615M, **Grade 60 (Grade 420)** bars, as required by unit size, profile, and thickness.
5. Abrasive Inserts: **1/2-inch- (13-mm-)** wide, silicon carbon/epoxy mixture.

a. Provide three inserts, **1/2 inch (13 mm)** apart, with first insert located **1 inch (25 mm)** from nosing at adjacent stair riser locations.

6. Color: As selected by Architect from manufacturer's standard color selections, as directed by the Owner.
7. Finish: Honed.
8. Surface Sealer: Slip- and stain-resistant, penetrating sealer that is chemically neutral with pH factor between 7 and 8; does not affect color or physical properties of terrazzo type indicated; is recommend by sealer manufacturer for use with specified terrazzo; and complies with NTMA guide specification for terrazzo type applicable for this Project.

2.8 EPOXY-RESIN-FILLED TREADS

A. Epoxy-Resin-Filled Treads: **3/8-inch- (9.5-mm-)** thick, epoxy resin with **8000-psi (55 158-kPa)** compressive strength; set on steel subtread.

1. Color: As selected by Architect from manufacturer's standard color selections, as directed by the Owner.

2.9 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts,[**railings and guards,**] clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs[**, railings, and guards**] in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #1 - No evidence of welded joint**][**Finish #2 - Completely sanded joint with some undercutting and pinholes okay**][**Finish # 3 - Partially dressed weld with spatter removed**][**Finish # 4 - Good quality, uniform undressed weld with minimal splatter**].

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.
3. Fabricate joints that will be exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.10 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for [**Architectural**][**Commercial**][**Service**] Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Stringers: Fabricate of [**steel plates**][**or**][**steel channels**][**or**][**steel rectangular tubes**][**as indicated on Drawings**].

   a. Stringer Size: [**As required to comply with "Performance Requirements" Article**][**As indicated on Drawings**].
   b. Provide closures for exposed ends of channel and rectangular tube stringers.
   c. Finish: [**Shop primed**][**Painted**][**Galvanized**].

2. Platforms: Construct of [**steel plate**][**or**][**steel channel**][**or**][**steel rectangular tube**] headers and miscellaneous framing members as [**required to comply with "Performance Requirements" Article**][**indicated on Drawings**].

   a. Provide closures for exposed ends of channel and rectangular tube framing.
   b. Finish: [**Shop primed**][**Painted**][**Galvanized**].

3. Weld[**or bolt**] stringers to headers; weld[**or bolt**] framing members to stringers and headers.[**If using bolts, fabricate and join so bolts are not exposed on finished surfaces.**]
4. Where stairs are enclosed by gypsum board[**shaft-wall**] assemblies, provide hanger rods or struts to support landings from floor construction above or below.

   a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel

sheet of thickness needed to comply with performance requirements, but not less than **0.067 inch (1.7 mm)**.

1. Fabricate treads and landing subplatforms of exterior stairs so finished walking surfaces slope to drain.
2. Steel Sheet, Uncoated: [**Cold**][**Hot**]-rolled steel sheet[**unless otherwise indicated**].
3. Galvanized Steel Sheet: Galvanized steel sheet[**, where indicated**].
4. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
5. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
6. Shape metal pans to include nosing integral with riser.
7. Attach abrasive nosings to risers.
8. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.
9. Provide epoxy-resin-filled treads, reinforced with glass fibers, with non-slip-concrete aggregate finish to tread surface.
10. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

    a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

D. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than **0.097 inch (2.5 mm)**.

1. Steel Sheet: Uncoated, hot-rolled steel sheet unless otherwise indicated.
2. Directly weld risers and treads to stringers; locate welds on underside of stairs.
3. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
4. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

2.11 FABRICATION OF STAIR RAILINGS AND GUARDS

A. Comply with applicable requirements in [**Section 055213 "Pipe and Tube Railings."**][**Section 057300 "Decorative Metal Railings."**]

B. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: [**1-5/8-inch- (41-mm-) diameter**][**1-1/2-inch- (38-mm-) square**] top and bottom rails and **1-1/2-inch- (38-mm-)** square posts.
2. Picket Infill: [**1/2-inch- (13-mm-)**][**3/4-inch- (19-mm-)**][**round**][**square**] pickets spaced to prohibit the passage of a **4-inch (100-mm)** diameter sphere.
3. Expanded-Metal Infill: Expanded-metal panels edged with U-shaped channels made from steel sheet and not less than **0.043 inch (1.1 mm)** thick. Orient expanded metal with long dimension of diamonds [**parallel to top rail**][**perpendicular to top rail**][**vertical**].
4. Perforated-Metal Infill: Perforated-metal panels edged with U-shaped channels made from metal sheet, of same metal as perforated metal, and not less than **0.043 inch (1.1 mm)** thick. Orient perforated metal with pattern [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**][**as indicated on Drawings**].
5. Mesh Infill: [**Woven**][**Welded**]-wire mesh crimped into **1-by-1/2-by-1/8-inch (25-by-13-by-3-mm)**

steel channel frames. Orient wire mesh with [**diamonds vertical**][**wires perpendicular and parallel to top rail**][**wires horizontal and vertical**].

6. Intermediate Rails Infill: [**1-5/8-inch- (41-mm-) diameter**][**1-1/2-inch- (38-mm-) square**] intermediate rails spaced less than [**12 inches (305 mm)**][**21 inches (533 mm)**] clear.
7. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with [**cam-type, self-closing**][**spring**] hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

C. Welded Connections: Fabricate railings and guards with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.

   a. Provide weep holes where water may accumulate internally.

2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
3. Weld all around at connections, including at fittings.
4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
5. Obtain fusion without undercut or overlap.
6. Remove flux immediately.
7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #1 - No evidence of a welded joint**][**Finish #2 - Completely sanded joint, some undercutting and pinholes are okay**][**Finish #3 - Partially dressed weld with spatter removed**][**Finish #4 - Good quality, uniform undressed weld with minimal splatter**] as shown in NAAMM AMP 521.

D. Form changes in direction of railings and guards as follows:

1. As detailed.
2. By bending[**or by inserting prefabricated elbow fittings**].
3. By flush bends[**or by inserting prefabricated flush-elbow fittings**].
4. By radius bends of radius indicated[**or by inserting prefabricated elbow fittings of radius indicated**].
5. By inserting prefabricated [**elbow fittings**][**flush-elbow fittings**][**elbow fittings of radius indicated**].

E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

F. Close exposed ends of railing and guard members with prefabricated end fittings.

G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

1. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.

H. Connect posts to stair framing by direct welding unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

4. Provide type of bracket [**with flange tapped for concealed anchorage to threaded hanger bolt**][**with predrilled hole for exposed bolt anchorage**] and that provides **1-1/2-inch (38-mm)** clearance from inside face of handrail to finished wall surface.

J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.

1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.12 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: Prepare uncoated, ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL PAN STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs.

Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.

a. Clean bottom surface of plates.
b. Set plates for structural members on wedges, shims, or setting nuts.
c. Tighten anchor bolts after supported members have been positioned and plumbed.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Comply with requirements for welding in "Fabrication, General" Article.

F. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete.
2. Center nosings on tread width.

G. Install precast concrete treads with adhesive supplied by manufacturer.

H. Install precast terrazzo treads according to manufacturer's written instructions.

3.3 INSTALLATION OF RAILINGS AND GUARDS

A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.

1. Space posts at spacing indicated or, if not indicated, as required by design loads.
2. Plumb posts in each direction, within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3.5 m)**.
4. Secure posts, rail ends, and guard ends to building construction as follows:

a. Anchor posts to steel by [**welding**][**or**][**bolting**] to steel supporting members.
b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.

B. Install railing gates level, plumb, and secure for full opening without interference.

1. Attach hardware using tamper-resistant or concealed means.
2. Adjust hardware for smooth operation.

C. Attach handrails to wall with wall brackets.

1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
2. Secure wall brackets to building construction as[**required to comply with performance requirements.**][**follows:**]

a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
b. For hollow masonry anchorage, use toggle bolts.
c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
d. For steel-framed partitions, use hanger or lag bolts set into [**fire-retardant-treated**]wood backing between studs. Coordinate with stud installation to locate backing members.
e. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
f. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.4 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 51 13 00

SECTION 05 51 13 00A - FABRICATED METAL SPIRAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fabricated metal spiral stairs with steel central-supporting columns, radiating treads, and railings.

B. Related Requirements:

1. Section 062023 "Interior Finish Carpentry" for wood treads.
2. Section 096513 "Resilient Base and Accessories" for resilient treads.
3. Section 096816 "Sheet Carpeting" for carpeting treads.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for fabricated metal spiral stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate fabricated metal spiral stairs with finish flooring materials.

1.3 ACTION SUBMITTALS

A. Product Data: For fabricated metal spiral stairs, including railings. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for components.

B. Shop Drawings: For fabricated metal spiral stairs and railings. Include plans, elevations, sections, details, attachments to other work, and field measurements.

C. Samples for Initial Selection: For products involving selection of color, texture, or design.

D. Samples for Verification: For the following products, in manufacturer's standard sizes:

1. Treads.
2. Metal with painted finish.
3. Railing members.

E. Delegated Design Submittal: For fabricated metal spiral stairs and railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content

and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with fabricated metal spiral stairs by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fabricated metal spiral stairs from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fabricated metal spiral stairs and railings.

B. Structural Performance of Stairs: Fabricated metal spiral stairs are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]:

1. Uniform Load: [**40 lbf/sq. ft. (1.92 kN/sq. m)**][**100 lbf/sq. ft. (4.79 kN/sq. m)**].
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Railing Loads: Stairs are to withstand stresses resulting from railing loads in addition to loads specified above.
5. Deflection: Limit deflection of treads, landings, and framing members to [**L/360**] but not to exceed [**1/4 inch (6 mm)**].

C. Structural Performance of Railings: Railings are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]:

1. Handrails and Top Rails of Guards:

   a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
   b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

   a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
   b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance: Fabricated metal spiral stairs are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

2.3 SPIRAL STAIRS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Accent Stairs; ADPG, LLC**]
2. [**Boston Stair**]
3. [**Couturier Iron Craft, Inc.**]
4. [**Custom Iron**]
5. [**Duvinage LLC**]
6. [**Goddard Manufacturing**]
7. [**Innovative Metalcraft, LLC**]
8. [**Iron Shop (The)**]
9. [**Mylen Stairs**]
10. [**Salter Spiral Stair**]
11. [**Stairways Inc.**]
12. [**Steptoe & Wife Antiques Ltd**]

B. Center Column: [**Steel**][**or**][**aluminum**] pipe welded to baseplate for anchorage to floor structure. Brace column at upper floors by means of landings attached to column and floor structure unless otherwise indicated. Provide cap for column if top is exposed.

C. Treads, Cast Metal: Cast [**aluminum**][**iron**] treads[**and platforms**] with integral frames, legs, and hubs.

1. Provide treads[**and platforms**] with abrasive surfaces.

D. Treads, Metal Bar Grating: Steel-bar grating treads[**and platforms**] with welded hubs and as follows:

1. Radial grating treads.
2. [**Abrasive**][**Rolled-steel, floor-plate**] nosings.
3. Straight flanges and welded-on legs.
4. Tapered flanges without legs.

E. Treads, Formed Metal Plate: Formed [**steel-**][**aluminum-**]plate treads[**and platforms**], welded to hubs or center column, and as follows:

1. Straight flanges and welded-on legs.
2. Tapered flanges without legs.
3. Pan treads without legs.
4. One-piece treads and risers, [**with**][**without**] legs.
5. Rolled-steel, floor-plate wearing surfaces.
6. Aluminum-alloy, rolled tread-plate wearing surfaces.
7. Smooth steel-plate wearing surfaces.
8. Rubber wearing surfaces.
9. Plywood subtread for covering with finish flooring specified in another Section.

F. Treads, Metal Framed: Steel-framed treads[**and platforms**], welded to hubs or center column, and without legs; wearing surface as follows:

1. Cast iron with integral abrasive.
2. Smooth steel plate with integral abrasive.
3. Wood.
4. Plywood insert for covering with finish flooring specified in another Section.

G. Railings: Uniformly bent to spiral shape[**, and continuing at top to form guardrail around floor opening**].

1. Space balusters less than [**4 inches (102 mm)**][**4-3/8 inches (111 mm)**], clear.
2. Space balusters to provide one baluster per tread, and less than [**21 inches (533 mm)**][**30 inches (762 mm)**], clear.
3. Space intermediate rails less than [**4 inches (101 mm)**][**4-3/8 inches (111 mm)**][**21 inches (533 mm)**], clear.
4. Locate bottom rail so that a [**6-inch- (152-mm-)**]diameter sphere cannot pass between the stair and rail.
5. Hand Rail:

    a. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] steel [**pipe**][**or**][**round tubing**].
    b. Steel of shape and size indicated.
    c. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] round [**aluminum**][**bronze**][**brass**][**stainless steel**] tubing.
    d. Extruded bronze of shape and size indicated.
    e. Wood of shape and size indicated.

6. Top Rail:

   a. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] steel [**pipe**][**or**][**round tubing**].
   b. Steel of shape and size indicated.
   c. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] round [**aluminum**][**bronze**][**brass**][**stainless steel**] tubing.
   d. Extruded bronze of shape and size indicated.
   e. Wood of shape and size indicated.

7. Balusters:

   a. [**7/8-inch- (22-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] steel pipe[**or round tubing**].
   b. [**1/2-inch- (13-mm-) OD**][**5/8-inch- (16-mm-) OD**] round steel [**bars**][**tubing**].
   c. [**1/2-inch- (13-mm-)**][**5/8-inch- (16-mm-)**][**3/4-inch- (19-mm-)**] square steel [**bars**][**tubing**].
   d. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**] round aluminum tubing.

8. Intermediate Rails:

   a. [**7/8-inch- (22-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] steel pipe[**or round tubing**].
   b. Steel pipe[**or round tubing**] same size as top rail.
   c. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**] round steel [**bars**][**tubing**].
   d. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] round aluminum tubing.
   e. Round aluminum tubing same size as top rail.

2.4 MATERIALS

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Brackets, Flanges, and Anchors: Same metal and finish as supported item unless otherwise indicated.

D. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

E. Steel Bars for Grating Treads and Platforms: ASTM A36/A36M or ASTM A1011/A1011M.

F. Wire Rod for Grating Crossbars: ASTM A510/A510M.

G. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or Grade D.

H. Steel Pipe Columns: ASTM A53/A53M, Schedule 40. Provide Schedule 80 for columns larger than **NPS 4 (DN 100)** and where required to support loads.

I. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

J. Steel Tubing: Either cold-formed steel tubing complying with ASTM A500/A500M or mandrel-drawn mechanical tubing complying with ASTM A513, Type 5.

K. Iron Castings: Either gray iron complying with ASTM A48/A48M or malleable iron complying with ASTM A47/A47M unless otherwise indicated or required by structural loads.

L. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.

M. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

N. Aluminum Pipe and Structural Round Tubing: ASTM B429/B429M, Alloy 6063-T6.

O. Extruded-Aluminum Tubing: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

P. Aluminum Castings: ASTM B26/B26M, Alloy 319.0-F.

Q. Extruded-Bronze Handrails: ASTM B455, Alloy UNS No. C38500 (architectural bronze).

R. Seamless Bronze Tubing: ASTM B135/B135M, Alloy UNS No. C23000 (red brass, 85 percent copper).

S. Seamless Brass Tubing: ASTM B135/B135M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).

T. Stainless Steel Tubing: ASTM A554, Grade MT 304.

U. Stainless Steel Sheet: Sheet, Strip, Plate, and Flat Bar: ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

V. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316**][**Type 316L**].

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: For connecting stair components and for anchoring stairs to other construction, select fasteners of type, grade, and class required to produce connections capable of withstanding design loadings.

1. For aluminum, provide fasteners fabricated from Type 304 stainless steel.
2. For stainless steel, provide fasteners fabricated from Type 304 stainless steel.
3. For steel and cast iron, use plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating.
4. For exterior locations, provide fasteners fabricated from Type 304 stainless steel.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

C. Lacquer for Brass and Bronze: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products.

1. Product: Subject to compliance with requirements, provide "Incralac" developed by International Copper Research Corporation.

D. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**]

E. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with finish paint systems indicated.

F. Shop Primer for Galvanized Steel: Primer formulated for use over zinc-coated metal and compatible with finish paint systems indicated.

G. Shop Primer for Aluminum: Primer formulated for use over aluminum and compatible with finish paint systems indicated.

H. Wood for Stair Treads, Handrails, and Platforms: Laminated red oak, sanded to 120-grit smoothness. Apply uniform coat of manufacturer's standard clear sealer.

I. Rubber Wearing Surfaces: Manufacturer's standard, **1/4-inch- (6-mm-)** thick, molded-rubber covering in pattern and color indicated or, if not indicated, as selected by Architect from manufacturer's standard colors and patterns.

2.6 FABRICATION

A. Assemble fabricated metal spiral stairs in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form work true to line and level with accurate angles and surfaces.

D. Fabricate connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

E. Cut, reinforce, drill, and tap as needed to receive hardware, screws, and similar items.

F. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. Finish exposed welds to comply with NOMMA Guideline 1, "Joint Finishes," for [**Finish #1 -No evidence of a welded joint**][**Finish #2 - Completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - Partially dressed weld with spatter removed**].
5. Finish exposed surfaces smooth and blended and, except for fillet welds, so welded surface matches contours of adjoining surfaces.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.7 STEEL AND IRON FINISHES

A. Galvanized Finish: Hot-dip galvanize fabricated metal spiral stairs and railings after fabrication to comply with ASTM A123/A123M.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6 (WAB)/NACE WAB-3, "Commercial Blast Cleaning."**][**SSPC-SP 7 (WAB)/NACE WAB-4, "Brush-off Blast Cleaning."**]

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter; treat with etching cleaner [**or**][**in accordance with SSPC-SP 16**].

D. Apply shop primer to prepared surfaces of handrails and railing components unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

2.8 ALUMINUM FINISHES

A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color:

a. [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
b. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (cleaned with inhibited chemicals; acid chromate-fluoride-phosphate conversion coating; shop primer).

1. Apply shop primer with a minimum dry film thickness of **1.5 mils (0.04 mm)**.

E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.9 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirrorlike finish**][**to match Architect's sample**].

D. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.
2. High Luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

2.10 BRASS AND BRONZE FINISHES

A. Buffed Finish: Mirror polished, buffed finish.

B. Lacquered Buffed Finish: Mirror polished, buffed finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

C. Lacquered Medium-Satin Finish: Directionally textured, medium satin, mechanical finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

D. Statuary Conversion Coating over Satin Finish: Directionally textured, fine satin, mechanical finish with sulfide conversion coating.

1. Color Match: Match Architect's sample, as directed by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where needed for securing fabricated metal spiral stairs to in-place construction; include threaded fasteners for concrete and masonry inserts, through bolts, lag bolts, wood screws, and other connectors as required.

B. Assemble fabricated metal spiral stair components to comply with manufacturer's written instructions, with each component aligned and in correct relation to each other, securely anchored to supporting column and adjacent structure.

C. Do not cut, alter, or drill stair components in the field that do not fit properly. Return components that do not fit to manufacturer for adjustment.

D. Install fabricated metal spiral stairs accurately in location, alignment, and elevation; level and plumb; and in accordance with manufacturer's written instructions.

E. Install fabricated metal spiral stairs by welding to steel structure or to weld plates cast into concrete unless otherwise indicated.

F. Field Welding:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

3.2 REPAIR

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material.

B. For galvanized surfaces, clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

1. Paint repaired areas with same material used for shop painting.

3.3 PROTECTION

A. Protect finished tread surfaces during construction by covering with **1/2-inch- (13-mm-)** thick, plywood secured with plastic strapping or another nonmarring fastening method.

END OF SECTION 05 51 13 00A

Task	Specification	Specification Description
05 51 13 00	05 50 00 00	Metal Fabrications

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SECTION 05 51 19 00 - METAL GRATING STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal grating stairs.
2. Steel railings and guards.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs[**railings, and guards**].

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts,[**blocking for attachment of wall-mounted handrails,**] and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.

D. Schedule installation of railings and guards so wall attachments are made only to completed walls.

1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For metal grating stairs and the following:

1. Gratings.
2. Woven-wire mesh.
3. Welded-wire mesh.
4. Shop primer products.
5. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

D. Delegated Design Submittal: For stairs[**railings, and guards**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the [**jurisdiction**][**State**] in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs[**railings, and guards**], including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to [**L/360**].

C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:
   a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
   b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.
2. Infill of Guards:
   a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
   b. Infill load and other loads need not be assumed to act concurrently.
3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   a. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

D. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 METALS

A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

D. Steel Bars for Grating Treads: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Steel Wire Rod for Grating Crossbars: ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Aluminum Bars for Grating Treads: **ASTM B221 (ASTM B221M)** extruded aluminum, alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.
3. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

G. Steel Tubing for Railings and Guards: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M**].

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Provide galvanized finish for exterior installations and where indicated.

H. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

I. Provide galvanized finish for exterior installations and where indicated.

J. Woven-Wire Mesh, Steel: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.135-inch (3.5-mm)** nominal-diameter steel wire complying with ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

K. Woven-Wire Mesh, Aluminum: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.162-inch- (4.1-mm-)** diameter, aluminum wire complying with **ASTM B211 (ASTM B211M)**, Alloy 6061-T94.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

L. Welded-Wire Mesh: [**Diamond**][**Square**] pattern, **2-inch (50-mm)** welded-wire mesh, made from **0.236-inch (6.0-mm)** nominal-diameter steel wire complying with ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

M. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

N. Cast-Abrasive Nosings: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.3 FASTENERS

A. General: Provide [**zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5**][**Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5**] where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated[**and capable of withstanding design loads**].

C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for [**exterior stairs**][**stairs indicated to be galvanized**][**stairs indicated to be shop primed with zinc-rich primer**].

E. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**] capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.4 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

D. Zinc-Rich Primer: Comply with SSPC-Paint 20, [**Type I-A**][**Type I-B**][**Type I-C**][**Type II**], Level [**1**][**2**][**3**], and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with [**SSPC-Paint 20**][**ASTM A780/A780M**] and compatible with paints specified to be used over it.

G. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for [**interior**][**exterior**] use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs[**railings, and guards**] in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish # 3 - Partially dressed weld with spatter removed**][**Finish #4 - Good quality, uniform undressed weld with minimal splatter**].

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.
3. Fabricate joints that are exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class,

unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel [**plates**][**or**][**channels**].

   a. Stringer Size: [**As required to comply with "Performance Requirements" Article**][**As indicated on Drawings**].
   b. Provide closures for exposed ends of channel stringers.
   c. Finish: [**Shop primed**][**Painted**][**Galvanized**].

2. Construct platforms and tread supports of steel [**plate**][**or**][**channel**] headers and miscellaneous framing members as [**required to comply with "Performance Requirements" Article**][**indicated on Drawings**].

   a. Provide closures for exposed ends of channel framing.
   b. Finish: [**Shop primed**][**Painted**][**Galvanized**].

3. Weld[**or bolt**] stringers to headers; weld[**or bolt**] framing members to stringers and headers.
4. Where stairs are enclosed by gypsum board[**shaft-wall**] assemblies, provide hanger rods or struts to support landings from floor construction above or below.

   a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from [**welded steel**][**or**][**pressure-locked steel**][**pressure-locked aluminum**] grating with [**1-1/4-by-3/16-inch (32-by-5-mm) bearing bars at 15/16 inch (24 mm) o.c.**][**1-by-3/16-inch (25-by-5-mm) bearing bars at 11/16 inch (17 mm) o.c.**][**1-by-1/8-inch (25-by-3-mm) bearing bars at 7/16 inch (11 mm) o.c.**] and crossbars at **4 inches (100 mm)** o.c.
2. Fabricate treads and platforms from [**welded steel**][**or**][**pressure-locked steel**][**pressure-locked aluminum**] grating with openings in gratings no more than [**5/16 inch (8 mm)**][**1/2 inch (12 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] in least dimension.

   a. Surface: [**Plain**][**Serrated**].
   b. Finish: [**Shop primed**][**Painted**][**Galvanized**][**Mill**].

3. Fabricate grating treads with [**rolled-steel floor plate**][**cast-abrasive**] nosing and with steel angle or steel plate carrier at each end for stringer connections.

   a. Secure treads to stringers with bolts.

4. Fabricate grating platforms with nosing matching that on grating treads.

   a. Secure grating to platform framing [**by welding**][**with bolts**].

D. Risers: [**Open**][**Solid**].

E. Toe Plates: Provide toe plates around openings and at edge of open-sided floors and platforms, and at open ends and open back edges of treads.

1. Material and Finish: Steel plate to match finish of other steel items.
2. Fabricate to dimensions and details indicated.

2.7 FABRICATION OF STAIR RAILINGS AND GUARDS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

B. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: [**1-5/8-inch- (41-mm-) diameter**][**1-1/2-inch- (38-mm-) square**] top and bottom rails and **1-1/2-inch- (38-mm-)** square posts.
2. Picket Infill: [**1/2-inch- (13-mm)**][**3/4-inch (19-mm)**][**round**][**square**] pickets spaced to prohibit the passage of a **4-inch (100-mm)** diameter sphere.
3. Mesh Infill: [**Woven**][**Welded**]-wire mesh [**crimped**][**welded**] into **1-by-1/2-by-1/8-inch (25-by-13-by-3-mm)** steel channel frames. Orient wire mesh with [**diamonds vertical**][**wires perpendicular and parallel to top rail**][**wires horizontal and vertical**].
4. Intermediate Rails Infill: [**1-5/8-inch- (41-mm-) diameter**][**1-1/2-inch- (38-mm-) square**] intermediate rails spaced less than [**12 inches (305 mm)**][**21 inches (533 mm)**] clear.

C. Welded Connections: Fabricate railings and guards with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.
    a. Provide weep holes where water may accumulate internally.
2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
3. Weld all around at connections, including at fittings.
4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
5. Obtain fusion without undercut or overlap.
6. Remove flux immediately.
7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #3 - Partially dressed weld with spatter removed**][**Finish #4 - Good quality, uniform undressed weld with minimal splatter**] as shown in NAAMM AMP 521.

D. Form changes in direction of railings and guards as follows:

1. As detailed.
2. By bending[**or by inserting prefabricated elbow fittings**].
3. By flush bends[**or by inserting prefabricated flush-elbow fittings**].
4. By radius bends of radius indicated[**or by inserting prefabricated elbow fittings of radius indicated**].
5. By inserting prefabricated [**elbow fittings**][**flush-elbow fittings**][**elbow fittings of radius indicated**].

E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required.

1. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

F. Close exposed ends of railing and guard members with prefabricated end fittings.

G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

1. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.

H. Connect posts to stair framing by direct welding unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
4. Provide type of bracket [**with flange tapped for concealed anchorage to threaded hanger bolt**][**with predrilled hole for exposed bolt anchorage**] and that provides **1-1/2-inch (38-mm)** clearance from inside face of handrail to finished wall surface.

J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.

1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.8 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 3, "Power Tool Cleaning."**][**minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:**]

1. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interior Stairs:

    a. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    b. SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces.

a. Clean bottom surface of baseplates.
b. Set steel-stair baseplates on wedges, shims, or leveling nuts.
c. After stairs have been positioned and aligned, tighten anchor bolts.
d. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Comply with requirements for welding in "Fabrication, General" Article.

3.3 INSTALLATION OF RAILINGS AND GUARDS

A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.

1. Space posts at spacing indicated or, if not indicated, as required by design loads.
2. Plumb posts in each direction, within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3.5 m)**.
4. Secure posts, rail ends, and guard ends to building construction as follows:

a. Anchor posts to steel by [**welding**][**or**][**bolting**] to steel supporting members.
b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.

B. Attach handrails to wall with wall brackets.

1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
2. Secure wall brackets to building construction as[**required to comply with performance requirements.**][**follows:**]

a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
b. For hollow masonry anchorage, use toggle bolts.
c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
d. For steel-framed partitions, use hanger or lag bolts set into [**fire-retardant-treated**]wood backing between studs. Coordinate with stud installation to locate backing members.
e. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
f. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.4 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 51 19 00

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Task	Specification	Specification Description
05 51 19 00	05 50 00 00	Metal Fabrications
05 51 19 00	05 51 13 00	Metal Pan Stairs
05 51 19 00	05 51 13 00a	Fabricated Metal Spiral Stairs
05 51 33 13	05 50 00 00	Metal Fabrications
05 51 33 13	05 52 13 00	Pipe And Tube Railings
05 51 33 16	05 50 00 00	Metal Fabrications
05 51 33 23	05 50 00 00	Metal Fabrications
05 51 33 23	05 52 13 00	Pipe And Tube Railings

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SECTION 05 52 13 00 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel railings.
2. Aluminum railings.
3. Stainless steel railings.

B. Related Requirements:

1. Section 055113 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.
2. Section 057300 "Decorative Metal Railings" for ornamental railings fabricated from pipes and tubes and guard-infill metals.
3. Section 096900 "Access Flooring" for railings included with access flooring.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Include plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For products involving selection of color, texture, or design [**, including mechanical finishes**] .

D. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.

a. Show method of [**connecting**][**and**][**finishing**] members at intersections.

E. Delegated Design Submittals: For railings, including analysis data signed and sealed by the qualified

professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For shop or field welding.

B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

E. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

F. Qualification Statements: For [**delegated design professional engineer**][**testing agency**] .

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality

Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of **50 lbf/ ft. (0.73 kN/m)** applied in any direction.
b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with [**flange tapped for concealed anchorage to threaded hanger bolt**][**predrilled hole for exposed bolt anchorage**] and that provides **1-1/2-inch (38-mm)** clearance from inside face of handrail to finished wall surface.

2.3 STEEL RAILINGS

A. Steel Railing:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hollaender Mfg. Co.**]
b. [**Kee Safety, Inc.**]
c. [**Trex Commercial Products, Inc.**]
d. [**TrueNorth Steel**]
e. [**VIVA Railings, LLC**]
f. [**Wagner Companies (The); R&B Wagner, Inc.**]

2. Source Limitations: Obtain each type of railing from single source from single manufacturer.

3. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of

preconsumer recycled content not less than 25 percent.

4. Tubing: [**ASTM A500/A500M (cold formed)**][**ASTM A513/A513M, Type 5**] .

5. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

   a. Provide galvanized finish for exterior installations and where indicated.

6. Plates, Shapes, and Bars: ASTM A36/A36M.
7. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
8. Expanded Metal Infill Panels: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**] , Class 1 (uncoated).

   a. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

9. Perforated-Metal Infill Panels, Steel:

   a. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel, Type B, [**0.060 inch (1.52 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

   b. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, commercial steel Type B, [**0.064 inch (1.63 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**][**with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows**].

10. Woven-Wire Mesh Infill Panels, Steel:

    a. Weave Type: Wove, intermediate crimp.
    b. Pattern: [**Diamond**][**Square**] .
    c. Mesh Size: **2-inch (50-mm)**.
    d. Wire: **0.134-inch- (3.42-mm-)** diameter steel wire complying with **ASTM A510 (ASTM A510M)**.

2.4 ALUMINUM RAILINGS

A. Aluminum Railing:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ATR Technologies, Inc.**]
   b. [**CraneVeyor Corp**]
   c. [**Hollaender Mfg. Co.**]
   d. [**Julius Blum & Co., Inc.**]
   e. [**Kane Innovations, Inc.**]
   f. [**Kattsafe**]
   g. [**Kee Safety, Inc.**]
   h. [**Moultrie Rail Systems**]
   i. [**Superior Aluminum Products, Inc**]

j. [**Thompson Fabricating, LLC**]
k. [**TimberTech, AZEK Building Products; The AZEK Company LLC**]
l. [**Trex Commercial Products, Inc.**]
m. [**Tri Tech, Inc.**]
n. [**Tubular Specialties Manufacturing, Inc.**]
o. [**Tuttle, a Dant Clayton Division**]
p. [**Wagner Companies (The); R&B Wagner, Inc.**]

2. Source Limitations: Obtain each type of railing from single source from single manufacturer.

3. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

4. Extruded Bars and Tubing: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

5. Extruded Structural Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.

   a. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

6. Drawn Seamless Tubing: ASTM B210/B210M, Alloy 6063-T832.

7. Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.
8. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.
9. Castings: ASTM B26/B26M, Alloy A356.0-T6.
10. Perforated Metal Infill Panels, Aluminum:

    a. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6, [**0.063 inch (1.60 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

11. Woven-Wire Mesh Infill Panels, Aluminum:

    a. Weave Type: Woven, intermediate crimp.
    b. Pattern: [**Diamond**][**Square**] .
    c. Mesh Size: **2 inches (50 mm)**.
    d. Wire: **0.162-inch- (4.1-mm-)** diameter aluminum wire complying with ASTM B211/B211M, Alloy 6061-T94.

2.5 STAINLESS STEEL RAILINGS

A. Stainless Steel Railing:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CraneVeyor Corp**]
   b. [**Julius Blum & Co., Inc.**]
   c. [**Kane Innovations, Inc.**]
   d. [**Stainless Fabricators, Inc**]
   e. [**Trex Commercial Products, Inc.**]
   f. [**Tri Tech, Inc.**]
   g. [**Tubular Specialties Manufacturing, Inc.**]

h. [**Tuttle, a Dant Clayton Division**]
i. [**VIVA Railings, LLC**]
j. [**Wagner Companies (The); R&B Wagner, Inc.**]

2. Source Limitations: Obtain each type of railing from single source from single manufacturer.

3. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316L**] .
4. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316L**] .

5. Castings: ASTM A743/A743M, [**Grade CF 8 or CF 20**][**Grade CF 8M or CF 3M**] .
6. Plate and Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**] .
7. Expanded Metal Infill Panels: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**] , Class 3 (corrosion-resistant steel), made from stainless steel sheet, ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] .

   a. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

8. Perforated Metal Infill Panels, Stainless Steel:

   a. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**] , [**0.062 inch (1.59 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

9. Woven-Wire Mesh Infill Panels: Stainless Steel:

   a. Weave Type: Woven, intermediate crimp.
   b. Pattern: [**Diamond**][**Square**] .
   c. **Mesh Size:2 inches (50 mm)**.
   d. Wire: **0.141-inch- (3.57-mm-)** diameter stainless steel wire complying with ASTM A580/A580M, [**Type 304**][**Type 316**] .

2.6 FASTENERS

A. Fastener Materials:

1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941/F1941M, Class Fe/Zn 5 for zinc coating.

2. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
3. Aluminum Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.
4. Stainless Steel Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.

5. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction [**and capable of withstanding design loads**] .

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to

other work, unless otherwise indicated.

2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

3. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction.

1. Acceptance Criteria: [**ICC-ES AC193**][**ICC-ES AC308**] .

2. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.7 MISCELLANEOUS MATERIALS

A. Handrail Brackets:

1. Material: [**Cast iron**][**Cast aluminum**][**Cast stainless steel**][**Cast nickel-silver**] .
2. Center of Handrail: [**2-1/2 inches (63.5 mm)**][**3-1/8 inches (79.4 mm)**] from [**face of railing**][**wall**] .

B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

1. For [**aluminum**][**and**][**stainless steel**] railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

D. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

F. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

G. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

H. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

I. Intermediate Coats and Topcoats: Provide products that comply with [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

J. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.

K. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

L. Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187/D1187M.

M. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

N. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: [**At exterior locations**][**and**][**where indicated on Drawings**] , provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.8 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage [**, but not less than that required to support structural loads**] .

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.

1. Clearly mark units for reassembly and coordinated installation.
2. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water.

1. Provide weep holes where water may accumulate.
2. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with [**welded**][**nonwelded**] connections unless otherwise indicated.

H. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards.

Provide with [**cam-type, self-closing**][**spring**] hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

I. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #1 welds; ornamental quality with no evidence of a welded joint**][**Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay**][**Finish #3 welds; utilitarian appearance not subject to view, partially dressed weld with spatter removed**] .

J. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

K. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.

L. Directional Changes:

1. Form changes in direction as detailed on Drawings.
2. Form changes in direction [**by bending**][**by inserting prefabricated elbow fittings**] .
3. Form changes in direction [**by flush bends**][**by inserting prefabricated flush-elbow fittings**] .
4. Form changes in direction [**by radius bends of radius indicated**][**by inserting prefabricated elbow fittings of radius indicated**] .
5. Form changes in direction by bending to smallest radius that will not result in distortion of railing member.

M. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

N. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

O. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.

P. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

Q. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.

1. Fabricate anchorage devices capable of withstanding loads imposed by railings.

2. Coordinate anchorage devices with supporting structure.

R. For railing posts set in concrete, provide stainless steel sleeves not less than **6 inches (150 mm)** long with inside dimensions not less than **1/2 inch (13 mm)** greater than outside dimensions of post, with metal plate forming bottom closure.

S. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.

1. Provide socket covers designed and fabricated to resist being dislodged.
2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

T. Expanded-Metal Infill Panels: Fabricate infill panels from expanded-metal sheet of same metal as railings.

1. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than **0.043 inch (1.1 mm)** thick.
2. Orient expanded metal with long dimension of diamonds [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**] .

U. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal.

1. Material: [**Steel**][**Galvanized steel**][**Aluminum**][**Stainless steel**][**Same metal as railings in which they are installed**] .
2. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than **0.043 inch (1.1 mm)** thick.
3. Orient perforated metal with pattern [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**][**as indicated on Drawings**] .

V. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into **1-by-1/2-by-1/8-inch (25-by-13-by-3-mm)** metal channel frames.

1. Fabricate wire mesh and frames from same metal as railings in which they are installed.
2. Orient wire mesh with [**diamonds vertical**][**diamonds perpendicular to top rail**][**wires perpendicular and parallel to top rail**][**wires horizontal and vertical**][**as indicated on Drawings**] .

W. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.9 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize [**exterior**][**indicated**] steel railings, including hardware, after fabrication.
2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.

4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as

weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner [**and as follows**] .

1. Comply with SSPC-SP 16.

D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.

E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3.**][**SSPC-SP 3.**][**requirements indicated below:**]

1. Exterior Railings: SSPC-SP 6/NACE No. 3.
2. Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.
3. Railings Indicated To Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
4. Other Railings: SSPC-SP 3.

F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated railings with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**][**primers specified in Section 099114 "Exterior Painting (MPI Standards)" and Section 099124 "Interior Painting (MPI Standards)"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**][**primers specified in Section 099601 "High-Performance Coatings (MPI Standards)" are**] indicated.

2. Do not apply primer to galvanized surfaces.

G. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

H. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.10 ALUMINUM FINISHES

A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Mill Finish: AA-M12, nonspecular as fabricated.

C. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41**][**AA-M12C22A31**] .

D. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44**][**AA-M12C22A32/A34**] .

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**] as directed by the Owner.

E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

F. High-Performance Organic Finish, Two-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

G. Superior Performance Organic Finish, Three-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

H. Superior Performance Organic Finish, Four-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

I. Single-Coat Superior Performance FEVE Organic Finish: Single-coat fluoroethylene vinyl ether (FEVE) fluoropolymer finish, complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

J. Two-Coat Superior Performance FEVE Organic Finish: Two-coat fluoroethylene vinyl ether (FEVE) fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.11 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces.
3. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Pipe and Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.

2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.

3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirror-like finish**][**to match Architect's sample**] as directed by the Owner.

D. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480, No. 4.

2. High-Luster Finish: ASTM A480/A480M, No. 7.

3. Mirror Finish: ASTM A480/A480M, No. 8.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION OF PIPE AND TUBE RAILINGS, GENERAL

A. Perform cutting, drilling, and fitting required for installing railings.

1. Fit exposed connections together to form tight, hairline joints.
2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

5. Set posts plumb within a tolerance of **1/16 inch in 3 ft. (2 mm in 1 m)**.

6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 ft, (6 mm in 3.5 m)**.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending **2 inches (50 mm)** beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within **6 inches (150 mm)** of post.

3.4 ANCHORING POSTS

A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**anchoring cement**] , mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than **5 inches (125 mm)** deep and **3/4 inch (20 mm)** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**anchoring cement**] , mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, [**welded to post after placing anchoring material**][**attached to post with setscrews**] .

D. Leave anchorage joint exposed with [**1/8-inch (3-mm) buildup, sloped away from post**][**anchoring material flush with adjacent surface**] .

E. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:

1. Steel Railings: Weld flanges to post and bolt to metal supporting surfaces.
2. Aluminum Railings: Attach posts as indicated on Drawings, using fittings designed and

engineered for this purpose.

3. Stainless Steel Railings: Weld flanges to post and bolt to supporting surfaces.

F. Install removable railing sections, where indicated, in slip-fit stainless steel sockets cast in concrete.

3.5 ATTACHING RAILINGS

A. Anchor railing ends to concrete and masonry with [**sleeves concealed within**][**flanges connected to**][**brackets on underside of rails connected to**] railing ends and anchored to wall construction with anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and [**welded to railing ends**][**connected to railing ends, using nonwelded connections**] .

C. Attach handrails to walls with wall brackets [**, except where end flanges are used**] . Provide brackets with [**1-1/2-inch (38-mm)**] clearance from inside face of handrail and finished wall surface.

1. Use type of bracket with [**flange tapped for concealed anchorage to threaded hanger bolt**][**predrilled hole for exposed bolt anchorage**] .
2. Locate brackets as indicated on Drawings or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets [**and railing end flanges**] to building construction.

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into [**fire-retardant-treated**] wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements, using self-tapping screws of size and type required to support structural loads.
6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

E. Install railing gates level, plumb, and secure for full opening without interference.

1. Attach hardware using tamper-resistant or concealed means.
2. Adjust hardware for smooth operation.

3.6 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

   a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop

paint are specified in [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

3.7 CLEANING

A. Clean [**aluminum**][**and**][**stainless steel**] by washing thoroughly with clean water and soap and rinsing with clean water.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.8 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 52 13 00

Task	Specification	Specification Description
05 52 13 00	05 50 00 00	Metal Fabrications

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SECTION 05 53 00 00 - EXPANDED METAL GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Expanded metal gratings.
2. Grating frames and supports.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
2. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Paint products.

B. Shop Drawings:

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For gratings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Welding certificates.

E. Delegated design engineer qualifications.

1.4 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.
3. AWS D1.3/D1.3M.
4. AWS D1.6/D1.6M.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors for Light Manufacturing: Uniform load of **125 lbf/sq. ft. (6.00 kN/sq. m)** or concentrated load of **2000 lbf (8.90 kN)**, whichever produces the greater stress.
2. Floors for Heavy Manufacturing: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **3000 lbf (13.40 kN)**, whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of **60 lbf/sq. ft. (2.87**

kN/sq. m).
4. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft. (4.79 kN/sq. m).
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 8000 lbf (35.60 kN), whichever produces the greater stress.
6. Limit deflection to [**L/360**] or 1/4 inch (6.4 mm), whichever is less.

C. Seismic Performance: Gratings to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Component Importance Factor: 1.5.

2.2 EXPANDED METAL GRATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Grating**]
2. [**AMICO, a Gibraltar Industries company**]
3. [**Central Expanded Metal, Inc.**]
4. [**Grating Pacific, Inc.**]
5. [**Nucor Grating; a Nucor company**]

B. Provide expanded metal gratings in material, finish, style, size, thickness, weight, and type indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.

1. Material: [**Steel**][**Stainless steel**][**Aluminum**].
2. Steel Finish: [**Unfinished, oiled**][**Shop primed**][**Galvanized**].
3. Stainless Steel Finish: Mill finish, as fabricated.
4. Aluminum Finish: Mill finish, as fabricated.
5. Style Designation for Steel: [**4.27 lb**][**3/4 number 9**].
6. Style Designation for Stainless Steel: [**1-1/2 number 9**][**3/4 number 9**].
7. Size for Aluminum: [**2 lb**][**3/4 0.188**][**1-1/2 0.125**].
8. Type: [**I, expanded**][**II, expanded and flattened**].

2.3 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior.
2. Interior[**, where indicated**].

2.4 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts, and, where indicated, flat washers; **ASTM F593 (ISO 3506-1)** for bolts and **ASTM F594 (ASTM F836M)** for nuts, Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Post-Installed Anchors: [**Torque-controlled expansion**][**or**][**chemical**] anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.6 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, **Grade 30 (Grade 205)**.

D. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, **Grade 33 (Grade 230)**, with **G90 (Z275)** coating.

E. Expanded Metal Carbon Steel: ASTM F1267, Class 1.

F. Expanded Metal Galvanized Steel: ASTM F1267, Class 2, Grade A.

G. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M, [**Type 304**][**Type 316L**].

H. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

I. Expanded Metal Stainless Steel: ASTM F1267, Class 3, made from stainless steel sheet, ASTM A240/A240M, [**Type 304**][**Type 316L**].

2.7 ALUMINUM

A. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

B. General: Provide alloy and temper recommended by aluminum producer for type of use indicated, with not less than the strength and durability properties of alloy, and temper designated below for each aluminum form required.

C. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, alloys as follows:

1. Alloy 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. Alloy 6061-T1, for grating crossbars.

D. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 5052-H32.

2.8 FABRICATION

A. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

C. Fit exposed connections accurately together to form hairline joints.

D. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion

resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates for attaching in the field.
2. Toeplate Height: **4 inches (100 mm)** unless otherwise indicated.

F. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with bars having a thickness not less than overall grating thickness at contact points.

G. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than **1/8 inch (3 mm)** thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

2.9 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Shop prime gratings, frames, and supports[**not indicated to be galvanized**] unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

3.2 INSTALLATION OF EXPANDED METAL GRATINGS

A. Comply with manufacturer's written instructions for installing gratings.

B. Place units with straight edge of bond up and with long direction of diamond-shaped openings parallel to direction of span.

C. Attach removable units to supporting members by bolting at **6-inch (150-mm)** intervals.

D. Attach nonremovable units to supporting members by welding unless otherwise indicated. Space welds at **6-inch (150-mm)** intervals.

E. Attach aluminum units to steel supporting members by bolting at **6-inch (150-mm)** intervals.

F. Butt edges parallel to long direction of diamond-shaped openings and weld at every second bond point. Place individual grating sections so diamonds of one piece are aligned with those of adjacent sections.

3.3 REPAIR

A. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on prime-painted gratings

immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 53 00 00

SECTION 05 53 13 00 - BAR GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal bar gratings.
2. Grating frames and supports.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
2. Section 055119 "Metal Grating Stairs" for grating treads and landings of steel-framed stairs.
3. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Clips and anchorage devices for gratings.
2. Paint products.

B. Shop Drawings:

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For gratings, including [**manufacturers' published load tables**][**analysis data signed and sealed by the qualified professional engineer responsible for their preparation**].

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Welding certificates.

E. Delegated design engineer qualifications.

1.4 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.
3. AWS D1.3/D1.3M.
4. AWS D1.6/D1.6M.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors for Light Manufacturing: Uniform load of **125 lbf/sq. ft. (6.00 kN/sq. m)** or concentrated load of **2000 lbf (8.90 kN)**, whichever produces the greater stress.
2. Floors for Heavy Manufacturing: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **3000 lbf (13.40 kN)**, whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of **60 lbf/sq. ft. (2.87**

kN/sq. m).
4. Walkways and Elevated Platforms Used as Exits: Uniform load of **100 lbf/sq. ft. (4.79 kN/sq. m)**.
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **8000 lbf (35.60 kN)**, whichever produces the greater stress.
6. Limit deflection to [**L/360**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Seismic Performance: Gratings to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Component Importance Factor: 1.5.

2.2 METAL BAR GRATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Grating**]
2. [**BarnettBates Corporation**]
3. [**Borden Metal Products (Canada) Limited**]
4. [**Grating Pacific, Inc.**]
5. [**Grupo Metelmex, S.A. de C.V.**]
6. [**IKG**]
7. [**MLP Steel Company; Laurel Steel Products Division**]
8. [**Neenah Foundry Company**]
9. [**Nucor Grating; a Nucor company**]
10. [**Ross Technology Company**]
11. [**Seidelhuber Metal Products; Brodhead Steel**]

B. Metal Bar Grating Standards: Comply with [**NAAMM MBG 531**][**and**][**NAAMM MBG 532**].

C. Welded Steel Grating:[**MBG-#.**]

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**][**1-3/8 inches (35 mm)**][**1-7/8 inches (48 mm)**][**2-3/8 inches (60 mm)**] o.c.
2. Bearing Bar Depth: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**4-1/2 inches (114 mm)**][**5 inches (127 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**As required to comply with structural performance requirements**].
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark W-11-4 (1 x 3/16) STEEL: **1-by-3/16-inch (25-by-4.8-mm)** bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark W-15-4 (1 x 1/8) STEEL: **1-by-1/8-inch (25-by-3.2-mm)** bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
7. Grating Mark W-19-4 (1-1/4 x 3/16) STEEL: **1-1/4-by-3/16-inch (32-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark W-19-4 (1-1/2 x 3/16) STEEL: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
9. Grating Mark W-19-4 (2 x 1/4) STEEL: **2-by-1/4-inch (51-by-6.4-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
10. Grating Mark W-30-4 (5 x 3/8) STEEL: **5-by-3/8-inch (127-by-9.5-mm)** bearing bars at **1-7/8**

inches (60 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
11. Grating Mark: As indicated.
12. Traffic Surface: [**Plain**][**Serrated**][**Knurled**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
13. Steel Finish: [**Shop primed**][**Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface**].

D. Pressure-Locked Steel Grating:[**MBG-#.**] Fabricated by [**pressing rectangular flush-top crossbars into slotted bearing bars**][**or**][**swaging crossbars between bearing bars**].

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**] o.c.
2. Bearing Bar Depth: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**As required to comply with structural performance requirements**].
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark P-11-4 (1 x 3/16) STEEL: **1-by-3/16-inch (25-by-4.8-mm)** bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark P-15-4 (1-1/4 x 1/8) STEEL: **1-1/4-by-1/8-inch (32-by-3.2-mm)** bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
7. Grating Mark P-19-4 (1-1/2 x 3/16) STEEL: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark: As indicated.
9. Traffic Surface: [**Plain**][**Serrated**][**Knurled**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
10. Steel Finish: [**Shop primed**][**Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface**].

E. Riveted Steel Grating:[**MBG-#.**]

1. Bearing Bar Spacing: [**3/4 inch (19 mm)**][**1-1/8 inches (29 mm)**][**2-5/16 inches (59 mm)**], clear.
2. Bearing Bar Depth: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**4-1/2 inches (114 mm)**][**5 inches (127 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**As required to comply with structural performance requirements**].
4. Rivet Spacing: [**3-1/2 inches (89 mm)**][**5 inches (127 mm)**][**7 inches (178 mm)**] o.c. along bearing bar.
5. Grating Mark R-12-3-1/2 (1 x 1/8) STEEL: **1-by-1/8-inch (25-by-3.2-mm)** bearing bars with **3/4-inch (19-mm)** clear space between bearing bars, and rivets at **3-1/2 inches (89 mm)** o.c. along bearing bar.
6. Grating Mark R-18-7 (1-1/2 x 3/16) STEEL: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars with **1-1/8-inch (29-mm)** clear space between bearing bars, and rivets at **7 inches (178 mm)** o.c. along bearing bar.
7. Grating Mark R-37-5 (4 x 1/4) STEEL: **4-by-1/4-inch (102-by-6.4-mm)** bearing bars with **2-5/16-inch (59-mm)** clear space between bearing bars, and rivets at **5 inches (127 mm)** o.c. along bearing bar.
8. Grating Mark R-37-5 (5 x 3/8) STEEL: **5-by-3/8-inch (127-by-9.5-mm)** bearing bars with **2-5/16-inch (59-mm)** clear space between bearing bars, and rivets at **5 inches (127 mm)** o.c. along bearing bar.
9. Grating Mark: As indicated.
10. Traffic Surface: [**Plain**][**Serrated**][**Knurled**][**Applied abrasive finish consisting of aluminum-**

oxide aggregate in an epoxy-resin adhesive][**As indicated**].

11. Steel Finish: [**Shop primed**][**Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface**].

F. Pressure-Locked, Stainless Steel Grating:[**MBG-#.**] Fabricated by [**pressing rectangular flush-top crossbars into slotted bearing bars**][**or**][**swaging crossbars between bearing bars**].

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**][**1-3/8 inches (35 mm)**][**1-7/8 inches (48 mm)**][**2-3/8 inches (60 mm)**] o.c.
2. Bearing Bar Depth: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**4-1/2 inches (114 mm)**][**5 inches (127 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**As required to comply with structural performance requirements**].
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark P-11-4 (1 x 3/16) STAINLESS STEEL: **1-by-3/16-inch (25-by-4.8-mm)** bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark P-15-2 (1 x 1/8) STAINLESS STEEL: **1-by-1/8-inch (25-by-3.2-mm)** bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **2 inches (51 mm)** o.c.
7. Grating Mark P-19-4 (1-1/2 x 3/16) STAINLESS STEEL: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark P-30-4 (3 x 3/8) STAINLESS STEEL: **3-by-3/8-inch (76-by-9.5-mm)** bearing bars at **1-7/8 inches (48 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
9. Grating Mark: As indicated.
10. Traffic Surface: [**Plain**][**Serrated**][**Knurled**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
11. Finish: [**Mill finish**][**Abrasive blasted**][**Electropolished**].

G. Pressure-Locked, Rectangular-Bar Aluminum Grating:[**MBG-#.**] Fabricated by [**pressing rectangular flush-top crossbars into slotted bearing bars**][**or**][**swaging crossbars between bearing bars**].

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17.5 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**] o.c.
2. Bearing Bar Depth: [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**As required to comply with structural performance requirements**].
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark P-7-4 (1 x 1/8) ALUMINUM: **1-by-1/8-inch (25-by-3.2-mm)** bearing bars at **7/16 inch (11 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark P-11-4 (1 x 3/16) ALUMINUM: **1-by-3/16-inch (25-by-4.8-mm)** bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
7. Grating Mark P-15-4 (1-1/2 x 3/16) ALUMINUM: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark P-19-4 (2 x 3/16) ALUMINUM: **2-by-3/16-inch (51-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
9. Grating Mark: As indicated.
10. Traffic Surface: [**Plain**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
11. Aluminum Finish: [**Mill finish**][**Class I, clear, anodized finish**].

H. Pressure-Locked, Aluminum I-Bar Grating:[**MBG-#.**] Fabricated by swaging crossbars between bearing bars.

1. Bearing Bar Spacing: [7/16 or 1/2 inch (11 or 13 mm)][11/16 inch (17 mm)][15/16 inch (24 mm)][1-3/16 inches (30 mm)] o.c.
2. Bearing Bar Depth: [1 inch (25 mm)][1-1/4 inches (32 mm)][1-1/2 inches (38 mm)][1-3/4 inches (44 mm)][2 inches (51 mm)][2-1/4 inches (57 mm)][2-1/2 inches (64 mm)][**As required to comply with structural performance requirements**].
3. Bearing Bar Flange Width: 1/4 inch (6.4 mm).
4. Crossbar Spacing: [2 inches (51 mm)][4 inches (102 mm)] o.c.
5. Grating Mark P-11-4 (1 I-Bar) ALUMINUM: 1-inch (25-mm) I-bar bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
6. Grating Mark P-15-2 (1 I-Bar) ALUMINUM: 1-inch (25-mm) I-bar bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 2 inches (51 mm) o.c.
7. Grating Mark P-19-4 (1-1/2 I-Bar) ALUMINUM: 1-1/2-inch (38-mm) I-bar bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
8. Grating Mark: As indicated.
9. Traffic Surface: [**Plain**][**Grooved**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
10. Aluminum Finish: [**Mill finish**][**Class I, clear, anodized finish**].

2.3 GRATING FRAMES AND SUPPORTS

A. Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior.
2. Interior[**, where indicated**].

2.4 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ISO 898-1, Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M), and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts, and, where indicated, flat washers; ASTM F593 (ISO 3506-1) for bolts and ASTM F594 (ASTM F836M) for nuts, Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563 (ASTM A563M), and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Post-Installed Anchors: [**Torque-controlled expansion**][**or**][**chemical**] anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.

D. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.

E. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, **Grade 30 (Grade 205)**.

F. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, **Grade 33 (Grade 230)**, with **G90 (Z275)** coating.

G. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M, [**Type 304**][**Type 316L**].

H. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

2.7 ALUMINUM

A. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

B. General: Provide alloy and temper recommended by aluminum producer for type of use indicated, with not less than the strength and durability properties of alloy, and temper designated below for each aluminum form required.

C. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, alloys as follows:

1. Alloy 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. Alloy 6061-T1, for grating crossbars.

D. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 5052-H32.

2.8 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
2. Fabricate toeplates for attaching in the field.
3. Toeplate Height: **4 inches (100 mm)** unless otherwise indicated.

G. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.

2. Provide no fewer than four saddle clips for each grating section containing rectangular bearing bars **3/16 inch (4.8 mm)** or less in thickness and spaced **15/16 inch (24 mm)** or more o.c., with each clip designed and fabricated to fit over two bearing bars.
3. Provide no fewer than four weld lugs for each grating section containing rectangular bearing bars **3/16 inch (4.8 mm)** or less in thickness and spaced less than **15/16 inch (24 mm)** o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
4. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
5. Furnish threaded bolts with nuts and washers for securing grating to supports.
6. Furnish self-drilling fasteners with washers for securing grating to supports.
7. Grating Clamps: Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Kee Safety, Inc.**]
        2) [**Lindapter International**]
        3) [**LNA Solutions, a Kee Safety company**]

H. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

I. Do not notch bearing bars at supports to maintain elevation.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I.

2.10 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Shop prime gratings, frames, and supports[**not indicated to be galvanized**] unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial**

Blast Cleaning."][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: With a heavy coat of bituminous paint, coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals.

3.2 INSTALLATION OF METAL BAR GRATINGS

A. Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 REPAIR

A. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on prime-painted gratings immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 53 13 00

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Task	Specification	Specification Description
05 53 13 00	01 11 19 00	No Specification Required
05 53 13 00	05 50 00 00	Metal Fabrications
05 53 13 00	05 53 00 00	Expanded Metal Gratings

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SECTION 05 53 16 00 - PLANK GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formed-metal plank gratings.
2. Extruded-aluminum plank gratings.
3. Grating frames and supports.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
2. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Formed-metal plank gratings.
2. Extruded-aluminum plank gratings.
3. Paint products.

B. Shop Drawings:

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For gratings, including [**manufacturers' published load tables**][**analysis data signed and sealed by the qualified professional engineer responsible for their preparation**].

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.

10. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

B. Mill Certificates: Signed by manufacturers of stainless steel sheet certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Welding certificates.

E. Delegated design engineer qualifications.

1.4 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.
3. AWS D1.3/D1.3M.
4. AWS D1.6/D1.6M.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors for Light Manufacturing: Uniform load of **125 lbf/sq. ft. (6.00 kN/sq. m)** or concentrated load of **2000 lbf (8.90 kN)**, whichever produces the greater stress.

2. Floors for Heavy Manufacturing: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **3000 lbf (13.40 kN)**, whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of **60 lbf/sq. ft. (2.87 kN/sq. m)**.
4. Walkways and Elevated Platforms Used as Exits: Uniform load of **100 lbf/sq. ft. (4.79 kN/sq. m)**.
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **8000 lbf (35.60 kN)**, whichever produces the greater stress.
6. Limit deflection to [**L/360**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Seismic Performance: Gratings to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: 1.5.

2.2 FORMED-METAL PLANK GRATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMICO, a Gibraltar Industries company**]
2. [**Atkore Unistrut**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Grating Pacific, Inc.**]
5. [**IKG**]
6. [**Metalex**]
7. [**Nucor Grating; a Nucor company**]

B. C-Shaped Channels: Rolled from heavy sheet metal of thickness indicated, and punched in serrated diamond shape to produce raised slip-resistant surface and drainage holes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMICO, a Gibraltar Industries company**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**IKG**]
   d. [**Metalex**]
   e. [**Nucor Grating; a Nucor company**]

2. Channel Width: [**4-3/4 inches (121 mm)**][**7 inches (178 mm)**][**9-1/2 inches (241 mm)**][**11-3/4 inches (298 mm)**][**18-3/4 inches (476 mm)**][**24 inches (610 mm)**][**As indicated**][**As required to comply with structural performance requirements**].
3. Channel Depth: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**As indicated**][**As required to comply with structural performance requirements**].
4. Material: [**0.074-inch- (1.9-mm-) thick steel sheet, shop primed**][**0.104-inch- (2.65-mm-) thick steel sheet, shop primed**][**0.079-inch- (2.0-mm-) thick, hot-dip galvanized-steel sheet**][**0.108-inch- (2.8-mm-) thick, hot-dip galvanized-steel sheet**][**0.074-inch- (1.9-mm-) thick steel sheet, hot-dip galvanized after fabrication**][**0.104-inch- (2.65-mm-) thick steel sheet, hot-dip galvanized after fabrication**][**0.062-inch- (1.6-mm-) thick, stainless steel sheet**][**0.078-inch- (2.0-mm-) thick, stainless steel sheet**][**0.080-inch- (2.0-mm-) thick aluminum sheet**][**0.100-**

inch- (2.5-mm-) thick aluminum sheet].

2.3 EXTRUDED-ALUMINUM PLANK GRATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMICO, a Gibraltar Industries company**]
2. [**IKG**]
3. [**Ohio Gratings, Inc**]
4. [**Seidelhuber Metal Products; Brodhead Steel**]

B. Provide extruded-aluminum plank gratings in type, size, and finish indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.

1. Type: Extruded-aluminum planks approximately **6 inches (152 mm)** wide with multiple flanges approximately **1.2 inches (30 mm)** o.c., acting as bearing bars connected by a web that serves as a walking surface. Top surface has raised ribs to increase slip resistance.
2. Depth: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As required to comply with structural performance requirements**].
3. Perforations: [**None**][**Rectangular, 19/32 by 3 inches (15 by 76 mm), with adjacent rows staggered**][**19/32 inch (15 mm) square, with adjacent rows aligned**].
4. Finish: Mill finish, as fabricated.

2.4 GRATING FRAMES AND SUPPORTS

A. Frames and Supports: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors **24 inches (600 mm)** o.c. and provide minimum anchor units in the form of steel straps **1-1/4 inches (32 mm)** wide by **1/4 inch (6.4 mm)** thick by **8 inches (200 mm)** long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior.
2. Interior[**, where indicated**].

2.5 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts, and, where indicated, flat washers; **ASTM F593 (ISO 3506-1)** for bolts and **ASTM F594 (ASTM F836M)** for nuts, Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**] capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.6 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.7 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, **Grade 30 (Grade 205)**.

D. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, **Grade 33 (Grade 230)**, with **G90 (Z275)**

coating.

E. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M, [**Type 304**][**Type 316L**].

F. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

2.8 ALUMINUM

A. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

B. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

C. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, alloys as follows:

1. Alloy 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. Alloy 6061-T1, for grating crossbars.

D. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 5052-H32.

2.9 FABRICATION

A. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Fit exposed connections accurately together to form hairline joints.

C. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

D. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates for attaching in the field.
2. Toeplate Height: **4 inches (100 mm)** unless otherwise indicated.

E. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with metal sheet or bars having a thickness not less than grating material.

1. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

F. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than **1/8 inch (3.2 mm)** thick to the cut ends. Divide panels into

sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

2.10 ALUMINUM FINISHES

A. Class I, Clear Anodic Finish: AA-M12C22A41 complying with AAMA 611.

2.11 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Shop prime gratings, frames and supports[**not indicated to be galvanized**] unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: With a heavy coat of bituminous paint, coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals.

3.2 INSTALLATION OF METAL PLANK GRATINGS

A. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.

B. Attach removable units to supporting members by bolting at every point of contact.

C. Attach nonremovable units to supporting members by welding unless otherwise indicated. Comply with manufacturer's written instructions for size and spacing of welds.

D. Attach aluminum units to steel supporting members by bolting at side channels at every point of contact and by bolting intermediate planks at each end on alternate sides. Bolt adjacent planks together at midspan.

3.3 REPAIR

A. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on prime-painted gratings immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 53 16 00

Task	Specification	Specification Description
05 53 16 00	05 53 00 00	Expanded Metal Gratings
05 54 00 00	05 50 00 00	Metal Fabrications
05 55 13 00	05 50 00 00	Metal Fabrications
05 55 13 00	05 51 13 00	Metal Pan Stairs
05 55 13 00	05 51 13 00a	Fabricated Metal Spiral Stairs
05 55 16 00	05 50 00 00	Metal Fabrications
05 55 16 00	05 51 13 00	Metal Pan Stairs
05 55 16 00	05 51 13 00a	Fabricated Metal Spiral Stairs
05 56 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 58 00 00 - HEATING_COOLING UNIT COVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes heating-cooling unit enclosures.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Shop Drawings: Show fabrication and installation details for heating-cooling unit enclosures.

C. Samples for Initial Selection: For products involving selection of color, texture, or design[**, including mechanical finishes**].

D. Samples for Verification: For each type of exposed finish required, prepared on **6-inch- (150-mm-)** square Samples of metal of same thickness and material indicated for the Work.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For heating-cooling unit enclosures. Show dimensions of heating-cooling units, including locations of housing penetrations and attachments, and necessary clearances.

B. Qualification Data: For [**fabricator**][**organic-coating applicator**][**and**][**powder-coating applicator**].

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing heating-cooling unit enclosures similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups of typical heating-cooling unit enclosures as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver heating-cooling unit enclosures wrapped in protective coverings or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with heating-cooling unit enclosures by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design heating-cooling unit enclosures.

B. Structural Performance: Heating-cooling unit enclosures shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

1. Live Loads: **100 lbf/sq. ft. (4.8 kN/sq. m)** or a concentrated load of **300 lbf (1.3 kN)** on an area of **4 sq. in. (26 sq. cm)**, whichever produces the greater stress.

2.2 HEATING-COOLING UNIT ENCLOSURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airflex Industrial, Inc.**]
2. [**ARSCO Metals LLC**]
3. [**Barker Metalcraft**]
4. [**HVAC Custom Enclosure Co., LLC**]
5. [**Wenig Company (The)**]

B. Fabricate heating-cooling unit enclosures from metal of type and thickness indicated below:

1. Galvanized-Steel Sheet:

a. Framing: [**0.108 inch (2.74 mm)**][**Thickness required to comply with performance requirements**].
b. Sills and Stools: [**0.079 inch (2.01 mm)**][**Thickness required to comply with performance requirements**].
c. Front Panels and Bases: [**0.064 inch (1.63 mm)**].
d. Concealed Panels and Trim: [**0.040 inch (1.02 mm)**].
e. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

2. Steel Sheet:

a. Framing: [**0.105 inch (2.66 mm)**][**Thickness required to comply with performance requirements**].
b. Sills and Stools: [**0.075 inch (1.90 mm)**][**Thickness required to comply with performance requirements**].
c. Front Panels and Bases: [**0.060 inch (1.52 mm)**].
d. Concealed Panels and Trim: [**0.036 inch (0.91 mm)**].
e. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

C. Weld seams and connections unless otherwise indicated or unless other methods are necessary for access to heating and cooling equipment.

D. Incorporate stiffeners or laminated backing using noncombustible materials as needed for strength and rigidity.

1. Fill space between stiffeners with sound-deadening insulation attached to face sheet with insulation adhesive unless otherwise indicated.
2. Coat concealed faces of metal panels more than **6 inches (150 mm)** wide with a heavy coating of sound-deadening mastic applied at the minimum rate of **20 sq. ft./gal. (0.5 sq. m/L)**.

E. Provide louvers and grilles of size, type, and materials indicated.

1. For removable grilles, use modular units with recessed openings formed into surfaces of enclosures and without blank filler panels between grilles, so face panels and stools are continuous. Fabricate removable grilles and openings to precise tolerances to produce well-fitted assemblies free of warp or rattle, with grilles supported continuously along parallel edges and with tops flush with top of enclosure.

F. Incorporate removable tops and fronts where indicated or needed for access to heating-cooling units and to piping, ductwork, controls, and electrical service, with panels and openings as follows:

1. Fabricate with a fitting tolerance of not less than **1/32 inch (0.8 mm)** and not more than **1/16 inch (1.6 mm)** at each edge, with face of panels flush with adjoining fixed surfaces of enclosure.
2. Form panels for easy removal without interfering with adjoining construction or furniture. Hold panels in place with concealed clips and hardware that prevent warp and rattle.

G. Incorporate hinged access panels in enclosures for access to heating-cooling unit controls, as either separate elements or integrated with grille openings, as indicated or needed.

H. Coordinate construction, configuration, and dimensions of enclosures with those of heating-cooling units. Provide support for heating-cooling units and controls where indicated. Provide blind knockouts and supports for piping, ductwork, control lines, electrical conduit, and wiring where indicated or needed.

I. Locate fixed surfaces of enclosure to coincide precisely with window mullions and partition system terminations. Provide closures at ends of units, at recessed openings in base of units, and at other

locations where needed to conceal unfinished wall or floor surfaces, piping, conduit, ductwork, or heating-cooling units.

1. Provide built-in partitions (bulkheads) within enclosures between heating-cooling units, located to coincide with mullions and partition system terminations. Seal partitions to faces of enclosures with compressible gaskets or mastic sealing tape, and cover both sides of partitions with sound-deadening insulation attached to partitions with insulation adhesive.

2.3 SHEET METAL

A. Fabricate units from sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, either commercial steel or forming steel.

C. Steel Sheet: [**Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, exposed**][**or**][**electrolytic zinc-coated, ASTM A879/A879M, with steel sheet substrate complying with ASTM A1008/A1008M, commercial steel, exposed**].

2.4 MISCELLANEOUS MATERIALS

A. Gaskets: As required to seal joints in heating-cooling unit enclosures; as recommended in writing by heating-cooling unit enclosure manufacturer.

1. ASTM D1056, Type 1, Class A, and grade as recommended by gasket manufacturer to obtain seal for application indicated.
2. Closed-cell polyurethane foam, adhesive on two sides, and release paper protected.

B. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as necessary for strength, corrosion resistance, and compatibility in fabricated items.

C. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless[**otherwise indicated**][**exposed fasteners are unavoidable or are the standard fastening method**].
2. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Sound-Deadening Materials:

1. Insulation: Unfaced mineral-fiber blanket insulation complying with ASTM C665, Type I, and passing ASTM E136 test.
2. Mastic: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

E. Isolation Coating: Manufacturer's standard [**alkali-resistant coating**][**bituminous paint**][**epoxy coating**].

2.5 PAINTS AND COATINGS

A. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Shop Primers: Comply with [**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

D. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Water-based galvanized metal primer complying with MPI#134.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble heating-cooling unit enclosures in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of heating-cooling unit enclosures with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a **1/2-inch- (12-mm-)** wide hem on the concealed side, or ease edges to a radius of approximately **1/32 inch (1 mm)** and support with concealed stiffeners.

D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.

1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

E. Build in straps, plates, and brackets as needed to support and anchor heating-cooling unit enclosures to adjoining construction.

F. Provide support framing, mounting, and attachment clips; splice sleeves; fasteners; and accessories needed to install heating-cooling unit enclosures.

G. Where welding is indicated, weld joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

2.7 GALVANIZED-STEEL SHEET FINISHES

A. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

B. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

D. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Baked-Enamel Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Siliconized-Polyester Coating: After cleaning and pretreating, apply manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performance Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.8 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-

SP 8, "Pickling."

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.

C. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

D. Baked-Enamel Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of heating-cooling unit enclosures.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate and place heating-cooling unit enclosures level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install heating-cooling unit enclosures.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses.

E. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings."**]

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes of heating-cooling unit enclosures from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 05 58 00 00

SECTION 05 58 13 00 - COLUMN COVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes [**spackled-seam**][**and**][**snap-together**] metal column covers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Shop Drawings: Show fabrication and installation details for column covers.

C. Samples for Initial Selection: For products involving selection of color, texture, or design[**including mechanical finishes**].

D. Samples for Verification: For each type of exposed finish required, prepared on **6-inch- (150-mm-)** square Samples of metal of same thickness and material indicated for the Work.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**fabricator**][**organic-coating applicator**][**anodic finisher**][**and**][**powder-coating applicator**].

B. Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For [**mirrorlike stainless-steel finish**][**and**][**statuary conversion coating copper-alloy finish**] to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing column covers similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings

of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups of typical column covers.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver column covers wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

PART 2 - PRODUCTS

2.1 SPACKLED-SEAM COLUMN COVERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fry Reglet Corporation**]
2. [**MM Systems Corporation**]
3. [**Pittcon Industries**]

B. Form column covers from **0.125-inch (3.2-mm)** aluminum sheet complying with **ASTM B209 (ASTM B209M)**, with not less than strength and durability properties of Alloy 5005-H32; rolled to radii indicated. Taper edges of adjoining pieces of column covers, for taping and spackling, to **0.094-inch (2.4-mm)** thickness in approximately **1 inch (25 mm)** of width. Punch tapered edges for gypsum board screws at **1/2 inch (12 mm)** o.c., and mill grooves in tapered edge to improve bond with joint compound.

1. Support Framing: At vertical joints, provide **1-1/2-by-3-5/8-inch (38-by-89-mm)** steel channel support posts formed from **0.040-inch (1.0-mm)** galvanized steel.
2. Joint Treatment Materials: Provide joint treatment compounds and reinforcing tape complying with requirements in Section 092900 "Gypsum Board."

2.2 SNAP-TOGETHER COLUMN COVERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ATAS International, Inc.**]
2. [**Ceilings Plus**]
3. [**Construction Services, Inc.**]
4. [**Firestone Metal Products**]

5. [**Fry Reglet Corporation**]
6. [**Gordon Inc.**]
7. [**Hi-Tech Metals, Inc**]
8. [**Industrial Louvers Inc.**]
9. [**Kanalco Ltd**]
10. [**Leed Himmel Industries, Inc.**]
11. [**Metal Sales & Service, Inc.**]
12. [**MM Systems Corporation**]
13. [**Pittcon Industries**]
14. [**Protean Construction Products, Inc**]
15. [**SAF (Southern Aluminum Finishing Company, Inc.)**]
16. [**Southwest Metalsmiths, Inc.**]

B. Form column covers to shapes indicated from metal of type and minimum thickness indicated below. Return vertical edges and bend to form hook that engages continuous mounting clips.

1. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, with not less than strength and durability properties of Alloy 5005-H32, [**0.063 inch (1.60 mm)**] thick.

    a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Steel Sheet: Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, exposed, [**0.060 inch (1.52 mm)**] thick.

    a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

3. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], [**0.050 inch (1.27 mm)**] thick.

    a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

4. Bronze Sheet: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper) or Alloy UNS C23000 (red brass, 85 percent copper), [**0.051 inch (1.29 mm)**] thick.

    a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish**].

5. Brass Sheet: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper), [**0.051 inch (1.29 mm)**] thick.

    a. Finish: [**Buffed**][**Hand-rubbed**] finish, lacquered.

6. Column covers may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
7. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide flat surfaces where indicated.
8. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
9. Form returns at vertical joints to provide hairline V-joints.
10. Form returns at vertical joints to provide [**1/2-inch- (12-mm-)**][**3/4-inch- (18-mm-)**] wide reveal at joints. Provide snap-in metal filler strips at reveals that leave reveals [**1/2 inch (12 mm) deep**][**flush**].
11. Form returns at vertical joints to accommodate backer rod and sealant.
12. Fabricate column covers with hairline horizontal V-joints produced by forming returns on mating

ends of column cover sections. Locate horizontal joints as indicated.

13. Fabricate column covers without horizontal joints.
14. Fabricate column covers with horizontal butt joints, tightly fitted and backed with a sleeve for field splicing with adhesive.
15. Fabricate column covers with [**1/2-inch- (12-mm-) wide**] reveals at horizontal joints produced by forming returns on mating ends of column cover sections. Provide snap-in metal filler strips at reveals matching reveals at vertical joints. Locate horizontal joints as indicated.
16. Fabricate [**base**][**ceiling**] ring to [**match**][**contrast with**] column covers.
17. Fabricate with calk stop/stiffener ring.
18. Apply manufacturer's recommended sound-deadening [**insulation**][**mastic**] to backs of column covers.

2.3 MISCELLANEOUS MATERIALS

A. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting column covers and for attaching them to other work unless[**otherwise indicated**][**exposed fasteners are unavoidable or are the standard fastening method**].
2. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

B. Sound-Deadening Materials:

1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C665, Type I, and passing ASTM E136 test.
2. Mastic: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

C. Backing Materials: Provided or recommended by column cover manufacturer.

2.4 PAINTS AND COATINGS

A. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

B. Shop Primers: Comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

C. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION, GENERAL

A. Coordinate dimensions and attachment methods of column covers with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

B. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends.

2.6 GENERAL FINISH REQUIREMENTS

A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
2. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

D. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Superior-Performance Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.8 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.

C. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

D. Baked-Enamel Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.9 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

D. Directional Satin Finish: No. 4.

E. Dull Satin Finish: No. 6.

F. Satin, Reflective, Directional Polish: No. 7.

G. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.

2.10 COPPER-ALLOY FINISHES

A. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear,

organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

B. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

C. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**with color matching Architect's sample**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of column covers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate and place column covers plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install column covers.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

E. Apply joint treatment at joints of spackled-seam metal column covers. Comply with requirements in Section 092900 "Gypsum Board."

3.3 ADJUSTING AND CLEANING

A. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

B. Touchup Painting:

1. Immediately after erection, clean abraded areas of shop paint and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting" Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

C. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 05 58 13 00

Task	Specification	Specification Description
05 58 13 00	05 50 00 00	Metal Fabrications
05 58 13 00	05 58 00 00	Heating_Cooling Unit Covers

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SECTION 05 58 16 00 - DECORATIVE FORMED METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Beam wraps.
2. Closures and trim.
3. Decorative-metal-clad doors and frames.
4. Escalator enclosures.
5. Filler panels.
6. Lighting coves.
7. Metal base.
8. Mullion cladding.
9. Pipe system covers.
10. Pockets for window treatment.
11. Window stools.

B. Related Requirements:

1. Section 057000 "Decorative Metal" for decorative items made primarily from plate, bars, extrusions, tubes, castings, and other forms of metal, but which may include sheet metal components.
2. Section 076100 "Sheet Metal Roofing" for items made of formed metal for roofing.
3. Section 076200 "Sheet Metal Flashing and Trim" for items made of formed metal for flashings and trim.
4. Section 077100 "Roof Specialties" for items made of formed metal for parapets and copings.

1.2 COORDINATION

A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes of deterioration.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show fabrication and installation details for decorative formed metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Samples for Initial Selection: For products involving selection of color, texture, or design[**including mechanical finishes**].

E. Samples for Verification: For each type of exposed finish required, prepared on **6-inch- (150-mm-)** square Samples of metal of same thickness and material indicated for the Work.

F. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.

B. Qualification Data: For [**Installer**][**fabricator**][**organic-coating applicator**][**anodic finisher**][**powder-coating applicator**][**and**][**professional engineer**].

C. Mill Certificates: Signed by stainless steel manufacturers certifying that products furnished comply with requirements.

D. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For [**mirrorlike stainless steel finish**][**and**][**statuary conversion coating copper-alloy finish**] to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units.

B. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type

indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Installer Qualifications: Fabricator of products.

F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

B. Store products on elevated platforms in a dry location.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For decorative metal items, obtain each color, grade, finish, type, and variety of metal from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design decorative formed metal, including attachment to building construction.

B. Structural Performance: Decorative formed metal items, including anchors and connections, are to withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

1. Wind Loads on Exterior Items: [**As indicated on Drawings**][**20 lbf/sq. ft. (957 Pa)**][**30 lbf/sq. ft. (1436 Pa)**].

C. Seismic Performance: Exterior decorative formed metal items, including anchors and connections, are

to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: 1.0.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.

2.3 SHEET METAL

A. General: Fabricate products from sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Aluminum Sheet: Flat sheet complying with **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties of not less than Alloy 5005-H32.

D. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, either commercial steel or forming steel.

E. Steel Sheet: [**Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, exposed**][**or**][**electrolytic zinc-coated, ASTM A879/A879M, with steel sheet substrate complying with ASTM A1008/A1008M, commercial steel, exposed**].

F. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], stretcher-leveled standard of flatness.

G. Bronze Sheet: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper) or Alloy UNS C23000 (red brass, 85 percent copper).

H. Brass Sheet: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

I. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper.

J. Titanium Sheet: ASTM B265, Grade 1.

2.4 MISCELLANEOUS MATERIALS

A. Gaskets: As required to seal joints in decorative formed metal and remain [**airtight**][**weathertight**]; as recommended in writing by decorative formed metal manufacturer.

1. ASTM D1056, Type 1, Class A, grade as recommended by gasket manufacturer to obtain seal for application indicated.
2. Closed-cell polyurethane foam, adhesive on two sides, release paper protected.

B. Sealants, Exterior: Elastomeric sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

C. Sealants, Interior: Nonsag, paintable sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

D. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.

1. Use filler metals that will match the color of metal being joined and will not cause discoloration.

E. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable or are the standard fastening method**].
2. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

F. Structural Anchors: For applications indicated to comply with certain design loads, provide fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

G. Nonstructural Anchors: For applications not indicated to comply with design loads, provide fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

H. Anchor Materials:

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

I. Sound-Deadening Materials:

1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C665, Type I, and passing ASTM E136 test.
2. Mastic: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

J. Backing Materials: Provided or recommended by decorative formed metal manufacturer.

K. Laminating Adhesive: Adhesive recommended by metal fabricator that will fully bond metal to metal, will prevent telegraphing and oil-canning, and is compatible with substrate and noncombustible after curing.

L. Isolation Coating: Manufacturer's standard [**alkali-resistant coating**][**bituminous paint**][**epoxy coating**].

2.5 PAINTS AND COATINGS

A. Etching Cleaner for Galvanized Metal: Product formulated to remove grease and oil residue from metal surfaces and provide a clean, lightly etched surface to promote adhesion of coatings.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible

with paints specified to be used over it.

C. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

D. Shop Primers: Comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

E. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

F. Epoxy Zinc-Rich Primer: Compatible with topcoat.

G. Shop Primer for Galvanized Steel: [**Cementitious galvanized metal primer**][**Vinyl wash primer**][**Water-based galvanized metal primer**].

H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a **1/2-inch- (12-mm-)** wide hem on the concealed side, or ease edges to a radius of approximately **1/32 inch (1 mm)** and support with concealed stiffeners.

D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.

1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

E. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.

F. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.

G. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

1. Use welding and brazing procedures that will blend with and not cause discoloration of metal

being joined.

2.7 BEAM WRAPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hi-Tech Metals, Inc**]
2. [**Industrial Louvers Inc.**]
3. [**Metal Sales & Service, Inc.**]
4. [**MM Systems Corporation**]
5. [**SAF (Southern Aluminum Finishing Company, Inc.)**]
6. [**Southwest Metalsmiths, Inc.**]

B. Form beam wraps from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Steel Sheet: [**0.060 inch (1.52 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

C. Fabricate with calk stop angle to retain backer rod and sealant.

2.8 CLOSURES AND TRIM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fry Reglet Corporation**]
2. [**Pittcon Industries**]

B. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction[**with weathertight joints at exterior installations**].

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance**

organic coating][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view and not exposed to weather.

C. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.

D. Drill and tap holes needed for securing closures and trim to other surfaces.

E. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.

F. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

2.9 DECORATIVE-METAL-CLAD DOORS AND FRAMES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dawson Metal Co., Inc**]
2. [**InKan Limited**]
3. [**Krieger Specialty Products Company**]

B. Laminate metal sheets, of type and thickness indicated below, to faces of [**hollow-metal doors and frames**][**and**][**elevator entrances**] where indicated. Use adhesive that will fully bond metal to metal and that will prevent telegraphing and oil-canning.

1. Bronze Sheet: [**0.040 inch (1.02 mm)**].

   a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish, lacquered**].

2. Brass Sheet: [**0.040 inch (1.02 mm)**].

   a. Finish: [**Buffed**][**Hand-rubbed**] finish lacquered.

3. Stainless Steel Sheet: [**0.038 inch (0.95 mm)**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

4. Titanium Sheet: [0.025 inch (0.64 mm)].

    a. Finish: [**Dull**][**Bright**] matte.

2.10 ESCALATOR ENCLOSURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hi-Tech Metals, Inc**]
2. [**Metal Sales & Service, Inc.**]
3. [**Southwest Metalsmiths, Inc.**]

B. Form escalator enclosures from metal of type and thickness indicated below. Coordinate size of enclosures, location of cutouts, and method of attachment to adjoining construction.

1. Stainless Steel Sheet: [0.062 inch (1.59 mm)][**Thickness required to comply with performance requirements**].

    a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2. Bronze Sheet: [0.081 inch (2.05 mm)][**Thickness required to comply with performance requirements**].

    a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish**].

2.11 FILLER PANELS

A. Form filler panels for closing ends of partition systems and for other applications indicated. Form from two sheets of metal of type and thickness indicated below, separated by channels formed from the same material, producing a panel of same thickness as [**partitions**][**mullions**] unless otherwise indicated. Incorporate reveals, trim, and concealed anchorages for attaching to adjacent surfaces.

1. Galvanized-Steel Sheet: [0.064 inch (1.63 mm)].

    a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

2. Steel Sheet: [0.060 inch (1.52 mm)].

    a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

3. Filler panels may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

B. Fill interior of panel with sound-deadening insulation permanently attached to inside panel faces.

C. Adhesively attach gaskets to filler panel edges where they abut mullions or glazing. Use 1-inch- (25-mm-) square material, unless otherwise indicated, set approximately 1/4 inch (6 mm) into channeled edge of filler panel.

D. Attach gaskets to all edges of panels that abut adjacent surfaces to form a continuous seal. Use compressible gaskets or mastic sealing tape, applied to center of panel edges to be concealed from view, unless otherwise indicated.

E. Do not mechanically fasten filler panels to mullions.

2.12 LIGHTING COVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fry Reglet Corporation**]
2. [**Gordon Inc.**]
3. [**Hi-Tech Metals, Inc**]
4. [**MM Systems Corporation**]
5. [**Pittcon Industries**]

B. Form lighting coves from metal of type and thickness indicated below. Coordinate size of coves, location of cutouts for electrical wiring, and method of attachment to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Fabricate light coves with [**hairline butt joints**][**tapered edges for taping and spackling**].
5. Provide [**mitered corners, factory welded with backplates**][**factory endcaps**].
6. Lighting coves may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

2.13 METAL BASE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fry Reglet Corporation**]
2. [**Pittcon Industries**]

B. Form metal base from metal of type and thickness indicated below:

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

    a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**].

    a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2.14 MULLION CLADDING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hi-Tech Metals, Inc**]
2. [**Metal Sales & Service, Inc.**]
3. [**Southwest Metalsmiths, Inc.**]

B. Form mullion cladding from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

    a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

    a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**].

    a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2.15 PIPE SYSTEM COVERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ARSCO Metals LLC**]
2. [**JG Innovations, Inc.**]

B. Form pipe system covers from metal of type and thickness indicated below. Coordinate size of covers, location of cutouts for piping, and method of attachment to adjoining construction.

1. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

    a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance**

organic coating][**Powder coat**].

2. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

2.16 POCKETS FOR WINDOW TREATMENT

A. Form pockets from metal of type and thickness indicated below, with end closures. Coordinate dimensions and attachment methods with window treatment equipment, window frames, ceiling suspension system, and other related construction to produce a coordinated, closely fitting assembly.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Pockets for window treatment may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

B. Reinforce pockets for attaching window treatment equipment and hardware, or increase metal thickness.

C. Divide continuous pockets with built-in partitions located to separate adjoining drapery and blind units, to coincide with window mullions, and to receive filler panels at ends of partitions.

2.17 WINDOW STOOLS

A. Form window stools from metal of type and thickness indicated below, with end closures:

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**][**1.3 mm**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

4. Bronze Sheet: [**0.051 inch (1.29 mm)**].

   a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish**].

B. Weld seams at end closures.

C. Braze seams at end closures.

D. Apply sound-deadening [**insulation**][**mastic**] to underside of window stools.

2.18 GENERAL FINISH REQUIREMENTS

A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

D. Finish [**items indicated on Drawings**] after assembly.

E. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.19 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
2. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

D. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Superior-Performing Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.20 GALVANIZED-STEEL SHEET FINISHES

A. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

B. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

D. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Siliconized-Polyester Coating: Immediately after cleaning and pretreating, apply manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performing Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.21 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating.

C. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

D. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.22 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

D. Directional Satin Finish: No. 4.

E. Dull Satin Finish: No. 6.

F. Satin, Reflective, Directional Polish: No. 7.

G. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.

H. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.23 COPPER-ALLOY FINISHES

A. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

B. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

C. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

D. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

E. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**with color matching Architect's sample**].

F. Statuary Conversion Coating over Satin Finish, Lacquered: M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air dried, as specified below)[**with color matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

2.24 TITANIUM FINISHES

A. General: Fabricate items from finished titanium sheet, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective

covering.

B. Dull Matte Finish: Pickled and annealed.

C. Bright Matte Finish: Vacuum annealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.

E. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.

F. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

G. Install decorative-formed-metal-clad doors and frames to comply with requirements specified in Section 081113 "Hollow Metal Doors and Frames."

3.3 ADJUSTING AND CLEANING

A. Unless otherwise indicated, clean metals by washing thoroughly with water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

D. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 05 58 16 00

Task	Specification	Specification Description
05 58 16 00	05 58 00 00	Heating_Cooling Unit Covers
05 58 16 00	05 15 16 00	Decorative Metal
05 58 23 00	05 58 00 00	Heating_Cooling Unit Covers
05 59 65 00	01 11 19 00	No Specification Required
05 59 65 00	05 15 16 00	Decorative Metal

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Task	Specification	Specification Description
06 05 23 00	06 10 00 00	Rough Carpentry
06 05 23 00	06 13 00 00	Heavy Timber Construction
06 05 73 13	01 11 19 00	No Specification Required
06 05 73 33	06 10 00 00	Rough Carpentry
06 05 73 33	06 13 00 00	Heavy Timber Construction

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SECTION 06 10 00 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood products.
2. Wood-preservative-treated lumber.
3. Fire-retardant-treated lumber.
4. Dimension lumber framing.
5. Miscellaneous lumber.
6. Plywood backing panels.
7. Metal framing anchors.

B. Related Requirements:

1. Section 061533 "Wood Patio Decking" for elevated decks, including support framing.
2. Section 061600 "Sheathing" for sheathing, subflooring, and underlayment.
3. Section 061753 "Shop-Fabricated Wood Trusses" for wood trusses made from dimension lumber.
4. Section 064013 "Exterior Architectural Woodwork" for exterior wood stairs and railings.
5. Section 064023 "Interior Architectural Woodwork" for interior wood stairs and railings.
6. Section 313116 "Termite Control" for site application of borate treatment to wood framing.

1.2 DEFINITIONS

A. Boards or Strips: Lumber of less than **2 inches nominal (38 mm actual)** size in least dimension.

B. Dimension Lumber: Lumber of **2 inches nominal (38 mm actual)** size or greater but less than **5 inches nominal (114 mm actual)** size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

D. SBX: An inorganic boron used to prevent termites and fungal decay.

E. Lumber grading agencies, and abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Chain-of-Custody Qualification Data: For manufacturer and vendor.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.5 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. For exposed lumber indicated to receive a stained or natural finish, [**mark grade stamp on end or back of each piece**][**or**][**omit grade stamp and provide certificates of grade compliance issued by grading agency**] .
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:

1. Boards: [**15**][**19**] percent.
2. Dimension Lumber: [**15 percent**][**19 percent**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**][**19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**] unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Wood-Preservative-Treated Lumber by Pressure Process: AWPA U1, use categories as follows:

1. UC1, Interior/Dry: Interior construction continuously protected from weather or other sources of moisture. Include [**all rough carpentry.**][**the following items:**]

   a. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
   b. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   c. Wood floor plates that are installed over concrete slabs-on-grade.
   d. Wood furniture.
   e. Wood millwork.

2. UC2, Interior/Damp: Interior construction protected from weather, but may be subject to sources of moisture. Include [**all rough carpentry.**][**the following items:**]

   a. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
   b. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   c. Wood floor plates that are installed over concrete slabs-on-grade.
   d. Wood millwork.
   e. Wood flooring.

3. UC3A, Above Ground, Protected (Commodity Specification A): Coated wood products in exterior construction not in contact with ground but exposed to all weather cycles including intermittent wetting. Include [**all rough carpentry.**][**the following items:**]

   a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
   c. Wood siding and trim.

4. UC3A, Above Ground, Protected (All Other Commodity Specifications): Wood products in exterior

construction not in contact with ground, exposed to all weather cycles but either coated and installed in a manner that prevents prolonged wetting, or fully protected from liquid water by building design and construction. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
c. Wood floor plates that are installed over concrete slabs-on-grade.
d. Wood siding and trim.
e. Wood sheathing.

5. UC3B, Above Ground, Exposed (Commodity Specification A): Uncoated wood products in exterior construction not in contact with ground, exposed to all weather cycles including intermittent wetting, but with sufficient air circulation for wood to dry. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
c. Wood decking, railings, and joists and beams for decks that are not critical to the performance and safety of the entire system/construction and that are in locations easily accessible for maintenance, repair, or replacement.

6. UC3B, Above Ground, Exposed (All Other Commodity Specifications): Uncoated wood products in exterior construction not in contact with ground, exposed to all weather cycles including prolonged wetting. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.

7. UC4A, Ground Contact, General Use (Commodity Specification A): Non-critical wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, and wood products not in contact with ground but with ground contact-type hazards or that are critical or hard to replace. Include [**all rough carpentry.**][**the following items:**]

a. Wood framing members that are less than **6 inches (152 mm)** above the ground.
b. Joists and beams when they are difficult to maintain, repair, or replace and are critical to the performance and safety of the entire system/construction.

8. UC4A, Ground Contact, General Use (All Other Commodity Specifications): Non-critical wood products in contact with ground and exposed to all weather cycles, normal exposure conditions. Include [**all rough carpentry.**][**the following items:**]

a. Wood fence, deck, and guardrail posts.
b. Wood utility poles.

9. UC4B, Ground Contact, Heavy Duty (Commodity Specification A): Critical or difficult-to-replace wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, high decay potential, and saltwater splash. Include [**all rough carpentry.**][**the following items:**]

a. Wood foundations.

10. UC4C, Ground Contact, Extreme Duty (Commodity Specification A): Critical structural wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, severe environments, and extreme decay potential. Include [**all rough carpentry.**][**the following items:**]

    a. Wood foundation piling.

11. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. [**Do not use inorganic boron (SBX) for sill plates.**]
12. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
13. After treatment, redry [**boards**][**dimension lumber**] to 19 percent maximum moisture content.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**] .

D. Application: Treat [**all rough carpentry unless otherwise indicated.**][**items indicated on Drawings, and the following:**]

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 ft. (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Treatment is not to promote corrosion of metal fasteners.
2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when

tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber is to be tested in accordance with ASTM D5664 and design value adjustment factors are to be calculated in accordance with ASTM D6841. [**For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.**]

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. [**Kiln-dry plywood after treatment to maximum moisture content of 15 percent.**]

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency and other information required by authorities having jurisdiction.

1. For exposed lumber indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by testing agency**] .

E. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat [**all rough carpentry unless otherwise indicated.**][**items indicated on Drawings, and the following:**]

1. Framing for raised platforms.
2. Framing for stages.
3. Concealed blocking.
4. Framing for non-load-bearing partitions.
5. Framing for non-load-bearing exterior walls.
6. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
7. Plywood backing panels.

2.4 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions by Grade:

1. Grade: [**Construction or No. 2**][**Construction, Stud, or No. 3**][**Standard, Stud, or No. 3**] .
2. Application: [**All interior partitions**][**Interior partitions not indicated as load bearing**] .
3. Species:

a. Hem-fir (north); NLGA.
b. Southern pine or mixed southern pine; SPIB.
c. Spruce-pine-fir; NLGA.
d. Hem-fir; WCLIB, or WWPA.
e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
f. Northern species; NLGA.
g. Eastern softwoods; NeLMA.
h. Western woods; WCLIB or WWPA.

B. Load-Bearing Partitions by Grade:

1. Grade: [**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] .

2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .
3. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Southern pine or mixed southern pine; SPIB.
    e. Spruce-pine-fir; NLGA.
    f. Douglas fir-south; WWPA.
    g. Hem-fir; WCLIB or WWPA.
    h. Douglas fir-larch (north); NLGA.
    i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

C. Machine Stress-Rated (MSR) Lumber Partitions:

1. Grade: Any species of MSR dimension lumber with a grade of not less than [**2400f-2.0E**][**2100f-1.8E**][**1650f-1.5E**].
2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .

D. Load-Bearing Partitions by Performance:

1. Performance Requirement: Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.
2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .

E. Ceiling Joists:

1. Grade: [**Construction or No. 2**][**Construction, Stud, or No. 3**][**Standard, Stud, or No. 3**] .
2. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Douglas fir-larch (north); NLGA.
    e. Southern pine or mixed southern pine; SPIB.
    f. Spruce-pine-fir; NLGA.
    g. Hem-fir; WCLIB or WWPA.
    h. Douglas fir-south; WWPA.
    i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
    j. Northern species; NLGA.
    k. Eastern softwoods; NeLMA.
    l. Western woods; WCLIB or WWPA.

F. Joists, Rafters, and Other Framing by Grade:

1. Grade: [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] .
2. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Southern pine or mixed southern pine; SPIB.

e. Spruce-pine-fir; NLGA.
f. Douglas fir-south; WWPA.
g. Hem-fir; WCLIB or WWPA.
h. Douglas fir-larch (north); NLGA.
i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

G. Joists, Rafters, and Other Framing by Performance:

1. Performance Requirement: Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.

H. Exposed Framing: Hand-select material [**indicated to receive a stained or natural finish**] for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.

1. Species and Grade:

a. As indicated above for load-bearing construction of same type.
b. Hem-fir (north); [**Select Structural**][**No. 1**] grade; NLGA.
c. Southern pine; [**Select Structural**][**No. 1**][**No. 2**] grade; SPIB.
d. Douglas fir-larch; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.
e. Mixed southern pine; [**Select Structural**][**No. 1**][**No. 2**] grade; SPIB.
f. Spruce-pine-fir; [**Select Structural**][**No. 1**] grade; NLGA.
g. Douglas fir-south; [**Select Structural**][**No. 1**] grade; WWPA.
h. Hem-fir; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.
i. Douglas fir-larch (north); [**Select Structural**][**No. 1**] grade; NLGA.
j. Spruce-pine-fir (south); [**Select Structural**][**No. 1**] grade; NeLMA, WCLIB, or WWPA.
k. Eastern hemlock-balsam fir or eastern hemlock-tamarack; [**Select Structural**][**No. 1**] grade; NeLMA.
l. Beech-birch-hickory; [**Select Structural**][**No. 1**] grade; NeLMA.
m. Northern red oak; [**Select Structural**][**No. 1**] grade; NeLMA.
n. Redwood; [**Clear Heart Structural**][**Clear Structural**][**Select Structural**][**No. 1**] grade; RIS.
o. Mixed oak; [**Select Structural**][**No. 1**] grade; NeLMA.
p. Mixed maple; [**Select Structural**][**No. 1**] grade; NeLMA.
q. Western cedars; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.

2.5 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.
7. Utility shelving.

B. Dimension Lumber Items:

1. Grade: [**Construction or No. 2**][**Standard, Stud, or No. 3**] .
2. Species: [**Any species.**][**Any of the following species:**][**The following species:**]

a. Hem-fir (north); NLGA.
b. Mixed southern pine or southern pine; SPIB.
c. Spruce-pine-fir; NLGA.
d. Hem-fir; WCLIB or WWPA.
e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
f. Western woods; WCLIB or WWPA.
g. Northern species; NLGA.
h. Eastern softwoods; NeLMA.

C. Utility Shelving:

1. Lumber Moisture Content: [**15**][**19**] percent maximum.
2. Species and Grade:

a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; [**Premium or No. 2 Common (Sterling)**][**Standard or No. 3 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.
b. Mixed southern pine or southern pine; No. [**1**][**2**] grade; SPIB.
c. Hem-fir or hem-fir (north); [**Select Merchantable or No. 1 Common**][**Construction or No. 2 Common**] grade; NLGA, WCLIB, or WWPA.
d. Spruce-pine-fir (south) or spruce-pine-fir; [**Select Merchantable or No. 1 Common**][**Construction or No. 2 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.

D. Concealed Boards:

1. Lumber Moisture Content: [**15**][**19**] percent maximum.
2. Species and Grade: [**Any of the following:**][**The following:**]

a. Mixed southern pine or southern pine; No. [**2**][**3**] grade; SPIB.
b. Hem-fir or hem-fir (north); [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; NLGA, WCLIB, or WWPA.
c. Spruce-pine-fir (south) or spruce-pine-fir; [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.
d. Eastern softwoods; No. [**2**][**3**] Common grade; NeLMA.
e. Northern species; No. [**2**][**3**] Common grade; NLGA.
f. Western woods; [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; WCLIB or WWPA.

E. Roofing Nailers: Structural- or No. 2-grade lumber or better; kiln-dried Douglas fir, southern pine, or wood having similar decay-resistant properties.

F. Wood Blocking: For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

G. Wood Furring: For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.6 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1.

1. Grade: [**Exterior, A-C**][**Exterior, C-C Plugged**][**Exposure 1, C-D Plugged**][**, fire-retardant treated**] .
2. Thickness: As indicated on the drawings or, if not indicated, not less than [**1/2-inch (13-mm)**][**3/4-inch (19-mm)**] nominal thickness.

2.7 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329**][**of Type 304 stainless steel**] .
2. For redwood, use [**brass/bronze**][**stainless steel**][**hot-dip galvanized-steel**] fasteners.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on [**ICC-ES AC01**][**ICC-ES AC58**][**ICC-ES AC193**][**or**][**ICC-ES AC308**] as appropriate for the substrate.

2.8 ACCESSORIES

A. Metal Framing Anchors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**MiTek Industries, Inc.**]
    b. [**Simpson Strong-Tie Co., Inc.**]
    c. [**Tamlyn**]

2. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post **1 inch (25 mm)** above base and with **2-inch- (50-mm-)** minimum side cover, socket **0.062 inch (1.6 mm)** thick, and standoff and adjustment plates **0.108 inch (2.8 mm)** thick.
3. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

    a. Width: [**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**] .
    b. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**] .
    c. Length: [**16 inches (400 mm)**][**24 inches (600 mm)**][**As indicated**] .

4. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, **1-1/2 inches (38 mm)** wide by **0.050 inch (1.3 mm)** thick. [**Tie fastens to side of rafter or truss, face of top plates, and side of stud below.**]
5. Rafter Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, **2-1/4 inches (57 mm)** wide by **0.062 inch (1.6 mm)** thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.
6. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, **1-1/4 inches (32 mm)** wide by **0.050 inch (1.3 mm)** thick by **36 inches (914 mm)** long.
7. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.

    a. Bolt Diameter: [**5/8 inch (15.8 mm)**][**3/4 inch (19 mm)**] .
    b. Width: [**2-1/2 inches (64 mm)**][**3-3/16 inches (81 mm)**] .
    c. Body Thickness: [**0.108 inch (2.8 mm)**][**0.138 inch (3.5 mm)**] .
    d. Base Reinforcement Thickness: [**0.108 inch (2.8 mm)**][**0.239 inch (6.1 mm)**] .

8. Wall Bracing:

    a. T-shaped bracing made for letting into studs in saw kerf, **1-1/8 inches (29 mm)** wide by **9/16 inch (14 mm)** deep by **0.034 inch (0.85 mm)** thick with hemmed edges.
    b. Angle bracing made for letting into studs in saw kerf, **15/16 by 15/16 by 0.040 inch (24 by 24 by 1 mm)** thick with hemmed edges.

9. Materials: Unless otherwise indicated, fabricate from the following materials:

    a. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, **G60 (Z180)** coating designation.

        1) Use for interior locations unless otherwise indicated.

    b. Heavy-Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G185 (Z550)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

        1) Use for wood-preservative-treated lumber and where indicated.

    c. Stainless steel bars and shapes complying with ASTM A276/A276M.

        1) Stainless Steel: Type [**304**][**316**] .
        2) Use for exterior locations and where indicated.

B. Sill-Sealer Gasket:

1. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; **1-inch (25-mm)** nominal thickness, compressible to **1/32 inch (0.8 mm)**; selected from manufacturer's standard widths to suit width of sill members indicated.
2. Closed-cell neoprene foam, **1/4 inch (6.4 mm)** thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Sill-Sealer Gasket and Termite Barrier: Self-adhering sheet consisting of **64 mils (1.6 mm)** of rubberized asphalt laminated on one side to a **4-mil- (0.10-mm-)** thick, polyethylene-film reinforcement, and with release liner on adhesive side [**; formulated for application with primer or surface**

conditioner that complies with VOC limits of authorities having jurisdiction] .

D. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than **0.025 inch (0.6 mm)**.

1. Compound Material: [**Butyl rubber**][**or**][**rubberized asphalt**] .

E. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

1. Verify adhesives have a VOC content of [**70**] g/L or less.
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

F. Water-Repellent Preservative: Formulation containing 3-iodo-2-propynyl butylcarbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION OF ROUGH CARPENTRY, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate [**furring,**] nailers, blocking, [**grounds,**] and similar supports to comply with requirements for attaching other construction.

C. Plywood Backing Panels: Install backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. [**Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.**]

D. Metal Framing Anchors: Install anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Sill-Sealer Gasket: Install gasket to form continuous seal between sill plates and foundation walls.

F. Sill-Sealer Gasket and Termite Barrier: Install gasket and termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

G. Do not splice structural members between supports unless otherwise indicated.

H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than **16 inches (406 mm)** o.c.

I. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than **96 inches (2438 mm)** o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than **96 inches (2438 mm)** o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and **2-inch nominal (38-mm actual)** thickness.
3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than **100 sq. ft. (9.3 sq. m)** and to solidly fill space below partitions.
4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than **20 ft. (6 m)** o.c.

J. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

K. Field Application of Preservative Treatment: Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron (SBX) for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

L. Flexible Flashing: Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

M. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in ICC's "International Building Code" (IBC).
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
3. ICC-ES evaluation report for fastener.

N. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF ROOFING NAILERS

A. Install roofing nailers where indicated on Drawings and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with

other work involved.

B. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.

C. Securely attach roofing nailers to substrate to resist the designed outward and upward wind loads indicated on Drawings and in accordance with SPRI ED-1, Tables A6 and A7.

3.3 INSTALLATION OF WOOD BLOCKING

A. Install wood blocking where indicated on Drawings and where required for [**screeding or**] attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than **1-1/2 inches (38 mm)** wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.4 INSTALLATION OF WOOD FURRING

A. Install wood furring level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install **1-by-3-inch nominal- (19-by-63-mm actual-)** size furring [**horizontally**][**and**][**vertically**] at [**24 inches (610 mm)**][**600 mm**] o.c.

C. Furring to Receive Gypsum Board or Plaster Lath: Install **1-by-2-inch nominal- (19-by-38-mm actual-)** size furring vertically at [**16 inches (406 mm)**][**400 mm**] o.c.

3.5 INSTALLATION OF WALL AND PARTITION FRAMING

A. General: Provide single bottom plate and double top plates using members of **2-inch nominal (38-mm actual)** thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions [**and for load-bearing partitions where framing members bearing on partition are located directly over studs**] . Fasten plates to supporting construction unless otherwise indicated.

1. For exterior walls, provide [**2-by-6-inch nominal- (38-by-140-mm actual-)**][**2-by-4-inch nominal- (38-by-89-mm actual-)**] size wood studs spaced [**24 inches (610 mm)**][**16 inches (406 mm)**][**600 mm**][**400 mm**] o.c. unless otherwise indicated.
2. For interior partitions and walls, provide [**2-by-6-inch nominal- (38-by-140-mm actual-)**][**2-by-4-inch nominal- (38-by-89-mm actual-)**][**2-by-3-inch nominal- (38-by-64-mm actual-)**] size wood studs spaced [**24 inches (610 mm)**][**16 inches (406 mm)**][**600 mm**][**400 mm**] o.c. unless otherwise indicated.
3. Provide continuous horizontal blocking at midheight of partitions more than **96 inches (2438 mm)** high, using members of **2-inch nominal (38-mm actual)** thickness and of same width as wall or partitions.

B. Construct corners and intersections with three or more studs [**, except that two studs may be used for interior non-load-bearing partitions**] .

C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.

1. For non-load-bearing partitions, provide double-jamb studs and headers not less than **4-inch nominal (89-mm actual)** depth for openings **48 inches (1200 mm)** and less in width, **6-inch nominal (140-mm actual)** depth for openings **48 to 72 inches (1200 to 1800 mm)** in width, **8-inch nominal (184-mm actual)** depth for openings **72 to 120 inches (1800 to 3000 mm)** in width, and not less than **10-inch nominal (235-mm actual)** depth for openings **10 to 12 ft. (3 to 3.6 m)** in width.
2. For load-bearing walls, provide double-jamb studs for openings **60 inches (1500 mm)** and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated [**or, if not indicated, in accordance with Table R602.7(1) or Table R602.7(2), as applicable, in ICC's "International Residential Code for One- and Two-Family Dwellings"**] .

D. Provide diagonal bracing in [**exterior walls, at both walls of each external corner**][**walls, at locations indicated on Drawings**] , at 45-degree angle, full-story height unless otherwise indicated. Use [**1-by-4-inch nominal- (19-by-89-mm actual-) size boards, let-in flush with faces of studs**][**metal wall bracing, let into studs in saw kerf**] .

3.6 INSTALLATION OF FLOOR JOIST FRAMING

A. General: Install floor joists with crown edge up and support ends of each member with not less than **1-1/2 inches (38 mm)** of bearing on wood or metal, or **3 inches (76 mm)** on masonry. Attach floor joists as follows:

1. Where supported on wood members, by [**toe nailing or by**] using metal framing anchors.
2. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.

B. Fire Cuts: At joists built into masonry, bevel cut ends **3 inches (76 mm)** and do not embed more than **4 inches (102 mm)**.

C. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds **48 inches (1200 mm)**.

D. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than one-third depth of joist; do not locate closer than **2 inches (50 mm)** from top or bottom.

E. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist at ends of joists unless nailed to header or band.

F. Lap members framing from opposite sides of beams, girders, or partitions not less than **4 inches (102 mm)** or securely tie opposing members together. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist over supports.

G. Anchor members paralleling masonry with **1/4-by-1-1/4-inch (6.4-by-32-mm)** metal strap anchors spaced not more than **96 inches (2438 mm)** o.c., extending over and fastening to three joists. Embed anchors at least **4 inches (102 mm)** into grouted masonry with ends bent at right angles and extending **4 inches (102 mm)** beyond bend.

H. Provide solid blocking between joists under jamb studs for openings.

I. Under non-load-bearing partitions, provide double joists separated by solid blocking equal to depth of studs above.

1. Provide triple joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures.

J. Provide bridging of type indicated below, at intervals of **96 inches (2438 mm)** o.c., between joists.

1. Diagonal wood bridging formed from bevel-cut, **1-by-3-inch nominal- (19-by-64-mm actual-)** size lumber, double-crossed and nailed at both ends to joists.
2. Steel bridging installed to comply with bridging manufacturer's written instructions.

3.7 INSTALLATION OF CEILING JOIST AND RAFTER FRAMING

A. Ceiling Joists: Install with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.

1. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate, and nail to first joist or anchor with framing anchors or metal straps. Provide **1-by-8-inch nominal- (19-by-184-mm actual-)** size or **2-by-4-inch nominal- (38-by-89-mm actual-)** size stringers spaced **48 inches (1200 mm)** o.c. crosswise over main ceiling joists.

B. Rafters: Notch to fit exterior wall plates and [**toe nail or**] use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.

1. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and **2 inches (50 mm)** deeper. Bevel ends of jack rafters for full bearing against valley rafters.
2. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and **2 inches (50 mm)** deeper. Bevel ends of jack rafters for full bearing against hip rafter.

C. Provide collar beams (ties) as indicated or, if not indicated, provide **1-by-6-inch nominal- (19-by-140-mm actual-)** size boards between every third pair of rafters, but not more than **48 inches (1219 mm)** o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.

D. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions if any.

3.8 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00 00

Task	Specification	Specification Description
06 11 13 00	06 10 00 00	Rough Carpentry
06 11 16 00	01 11 19 00	No Specification Required
06 11 16 00	06 10 00 00	Rough Carpentry

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SECTION 06 13 00 00 - HEAVY TIMBER CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Timber.
2. Round wood poles.
3. Preservative-treated wood material.
4. Timber connectors.
5. Miscellaneous materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with heavy timber framing.
2. Section 061516 "Wood Roof Decking."
3. Section 061800 "Glued-Laminated Construction."

1.2 DEFINITIONS

A. Timbers: Lumber of **5 inches nominal (114 mm actual)** or greater in least dimension.

B. Poles: Round wood members, called either "poles" or "posts" in the referenced standards.

C. Inspection agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NHLA: National Hardwood Lumber Association.
3. NLGA: National Lumber Grades Authority.
4. SPIB: Southern Pine Inspection Bureau (The).
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For [**preservative-treated wood products**][**and**][**timber connectors**].

1. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. For timber connectors. Include installation instructions.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.

3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Shop Drawings: For heavy timber framing. Show layout, dimensions of each member, and details of connections.

D. Samples: Not less than [**5 inches (127 mm)**][**7 inches (178 mm)**][**9 inches (229 mm)**] wide by **24 inches (600 mm)** long, showing the range of variation to be expected in appearance, including surface texture, of wood products.[**Apply a coat of penetrating sealer to Samples.**]

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For timbers specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.[**For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.**]

B. Certificates of Inspection: Issued by lumber-grading agency for exposed timber not marked with grade stamp.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of materials to avoid extended on-site storage and to avoid delaying the Work.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings.

PART 2 - PRODUCTS

2.1 WOOD MATERIALS, GENERAL

A. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

I. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

J. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 TIMBER

A. Comply with DOC PS 20 and with grading rules of lumber-grading agencies certified by ALSC's Board of Review as applicable.

1. Factory mark each item of timber with grade stamp of grading agency.
2. For exposed timber indicated to receive a stained or natural finish, apply grade stamps to surfaces that are not exposed to view, or omit grade stamps and provide certificates of grade compliance issued by grading agency.

B. Timber Species and Grade:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); [**Select Structural**][**No. 1**][**No. 2**], NeLMA, NLGA, SPIB, WCLIB, or WWPA.
2. Alaska cedar; [**Select Structural**][**No. 1**][**No. 2**], WCLIB.
3. Douglas fir-larch or Douglas fir-larch (North); [**Dense Select Structural**][**Select Structural**][**No. 1 Dense**][**No. 1**][**No. 2**], NLGA, WCLIB, or WWPA.
4. Hem-fir or hem-fir (North); [**Select Structural**][**No. 1**][**No. 2**], NLGA, WCLIB, or WWPA.
5. Southern pine; [**Dense Select Structural**][**Select Structural**][**No. 1 Dense**][**No. 1**][**No. 2 Dense**][**No. 2**], SPIB.
6. [**Beech-birch-hickory**][**Mixed maple**][**Mixed oak**][**Northern red oak**][**Red maple**][**Red oak**][**White oak**]; [**Select Structural**][**No. 1**][**No. 2**], NeLMA.
7. [**Mixed hardwoods**][**Mixed oak**][**Red oak**][**White oak**]; [**Select Dimension**][**Common Dimension**][**Sound Square Edge**], NHLA.

C. Structural Properties: Provide any species and grade that, for moisture content provided, complies with required structural properties.

1. Allowable Stress Ratings for 12-Inch Nominal (286-mm Actual) Depth: [**Fb 1500 psi (10.3 MPa) and E 1,500,000 psi (10 340 MPa)**][**Fb 1300 psi (9.0 MPa) and E 1,300,000 psi (8 960 MPa)**][**As indicated on Drawings**].

D. Moisture Content: Provide timber with 19 percent maximum moisture content at time of dressing[**or provide timber that is unseasoned at time of dressing but with 19 percent maximum moisture content at time of installation**].

E. Dressing: Provide [**dressed timber (S4S)**][**timber that is rough sawn (Rgh)**] unless otherwise indicated.

2.3 ROUND WOOD POLES

A. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

2.4 PRESERVATIVE-TREATED WOOD MATERIAL

A. Pressure-treat materials with waterborne preservative according to AWPA U1; Use Category UC2[**for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground**].

B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or

chromium.

1. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants, bleed through, or otherwise adversely affect finishes.

C. Use process that includes water-repellent treatment.

D. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.

E. After treatment, redry materials to 19 percent maximum moisture content.

F. Mark treated materials with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For exposed items indicated to receive a stained or natural finish, [**mark each piece on surface that is not exposed**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

G. Application: [**Treat all heavy timber framing unless otherwise indicated.**][**Treat items indicated on Drawings and the following:**]

1. Sills and similar members in contact with masonry or concrete.
2. Timber framing members less than **18 inches (460 mm)** above grade.

2.5 TIMBER CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Halfen USA, Inc.**]
2. [**Simpson Strong-Tie Co., Inc.**]
3. [**USP Structural Connectors**]

B. Fabricate beam seats from [**steel**][**stainless steel**] with [**0.239-inch (6-mm)**][**3/16-inch (5-mm)**][**3/8-inch (9.5-mm)**] bearing plates, **3/4-inch- (19-mm-)** diameter-by-**12-inch- (300-mm-)** long deformed bar anchors, and **0.239-inch (6-mm)** side plates.

C. Fabricate beam hangers from [**steel**][**stainless steel**] with **0.179-inch (4.6-mm)** stirrups and **0.239-inch (6-mm)** top plates.

D. Fabricate strap ties from [**steel**][**stainless steel**], [**2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm)**][**3 inches (75 mm) wide by 0.239 inch (6 mm)**] thick.

E. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A668/A668M.

F. Provide bolts, **3/4 inch (19 mm)** unless otherwise indicated, complying with **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; provide nuts complying with **ASTM A563 (ASTM A563M)**; and, where indicated, provide flat washers.

G. Provide stainless steel bolts, **3/4 inch (19 mm)** unless otherwise indicated, complying with **ASTM F593,**

Alloy Group 1 or 2 (ASTM F738M, Grade A1 or A4); provide nuts complying with ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or A4); and, where indicated, provide flat washers.

H. Provide shear plates, [2-5/8 inches (66.7 mm)][4 inches (102 mm)] in diameter, complying with ASTM D5933.

I. Materials: Unless otherwise indicated, fabricate from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A36/A36M.
2. Round steel bars complying with ASTM A575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A1011/A1011M, Structural Steel, Type SS, Grade 33.
4. Stainless steel plate, sheet, and strip complying with ASTM 240/A240M or ASTM A666, [**Type 304**][**Type 316**].
5. Stainless steel flat bars complying with ASTM A666, [**Type 304**][**Type 316**].
6. Stainless steel bars and shapes complying with ASTM A276, [**Type 304**][**Type 316**].

J. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.

K. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A123/A123M or ASTM A153/A153M.

2.6 MISCELLANEOUS MATERIALS

A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.7 FABRICATION

A. Camber: Fabricate horizontal members and inclined members with a slope of less than 1:1, with natural convex bow (crown) up, to provide camber.

B. Shop fabricate members by cutting and restoring exposed surfaces to match specified surfacing. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.

C. Predrill for fasteners and assembly of units.

D. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.

1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Coat crosscuts with end sealer.

F. Seal Coat: After fabricating and surfacing each unit, apply a saturation coat of penetrating sealer on surfaces of each unit except for treated wood where the treatment included a water repellent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Erect heavy timber framing true and plumb. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

1. Install horizontal and sloping members with crown edge up, and provide not less than **4 inches (102 mm)** of bearing on supports. Provide continuous members unless otherwise indicated; tie together over supports with metal strap ties if not continuous.
2. Handle and temporarily support heavy timber framing to prevent surface damage, compression, and other effects that might interfere with indicated finish.

B. Framing Built into Masonry: Provide **1/2-inch (13-mm)** clearance at tops, sides, and ends of members built into masonry, and bevel cut ends **3 inches (76 mm)**; do not embed more than **4 inches (102 mm)** unless otherwise indicated.

C. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.

D. Fitting: Fit members by cutting and restoring exposed surfaces to match specified surfacing.

1. Predrill for fasteners using timber connectors as templates.
2. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Coat crosscuts with end sealer.
4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

    a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
    b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Install timber connectors as indicated.

1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
2. Install bolts with orientation as indicated or, if not indicated, as directed by the Owner.

3.2 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber framing if repairs are not approved by Architect, as directed by the Owner.

END OF SECTION 06 13 00 00

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Task	Specification	Specification Description
06 13 23 00	06 13 00 00	Heavy Timber Construction

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SECTION 06 15 00 00 - WOOD ROOF DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-sawn wood roof decking.
2. Glued-laminated wood roof decking.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with wood roof decking.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For glued-laminated wood roof decking, include installation instructions and data on lumber, adhesives, and fabrication.
2. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Samples: **24 inches (600 mm)** long, showing the range of variation to be expected in appearance of wood roof decking.

1.3 INFORMATIONAL SUBMITTALS

A. Research/Evaluation Reports: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, from ICC-ES.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of wood roof decking to avoid extended on-site storage and to avoid delaying the Work.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood roof decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 WOOD ROOF DECKING, GENERAL

A. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 SOLID-SAWN WOOD ROOF DECKING

A. Standard for Solid-Sawn Wood Roof Decking: Comply with AITC 112.

B. Roof Decking Species:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), hem-fir, hem-fir (North), southern pine, spruce pine-fir (North), western hemlock, or western hemlock (North).
2. [**Alaska cedar**][**Balsam fir**][**Douglas fir-larch or Douglas fir-larch (North)**][**Eastern spruce**][**Hem-fir or hem-fir (North)**][**Southern pine**].

C. Roof Decking Nominal Size: [**2 by 6**][**2 by 8**][**3 by 6**][**4 by 6**].

D. Roof Decking Grade:

1. [**Select(ed)**][**Commercial**] Decking.
2. [**Dense Standard**][**Dense Select**][**Select**][**Dense Commercial**][**Commercial**] Decking.
3. [**Select(ed) Decking or Select Dex**][**Commercial Decking or Commercial Dex**].

E. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that are not exposed to view.

F. Moisture Content: Provide wood roof decking with [**15**][**19**] percent maximum moisture content at time of dressing.

G. Face Surface: [**Rough sanded or wire brushed**][**Saw textured**][**Smooth**].

H. Edge Pattern: [**Beaded edge**][**Bullnosed**][**Channel grooved**][**Vee grooved**].

2.3 GLUED-LAMINATED WOOD ROOF DECKING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Structural Wood Systems; A Division of Harrison Industries**]

B. Face Species: [**Alaska cedar**][**Douglas fir-larch or Douglas fir-larch (North)**][**Ponderosa pine**][**Southern pine**][**Western cedars or western cedars (North)**].

C. Roof Decking Nominal Size: [**2 by 6**][**2 by 8**][**3 by 6**][**3 by 8**][**4 by 6**][**4 by 8**][**5 by 6**][**5 by 8**].

D. Roof Decking Configuration: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, provide tongue-and-groove configuration that complies with research/evaluation report.

E. Face Grade:

1. Custom or Supreme: Clear face is required. Occasional pieces may contain a small knot or minor characteristic that does not detract from the overall appearance.
2. Decorative: Sound knots and natural characteristics are allowed, including chipped edge knots, short end splits, seasoning checks, and some pin holes. Face knot holes, stains, end slits, skips, roller splits, and planer burns are not allowed.
3. Service: Face knot holes, stains, end splits, skips, roller splits, planer burns, and other nonstrength-reducing characteristics are allowed. Strength-reducing characteristics are not allowed.

F. Moisture Content: Provide wood roof decking with 15 percent maximum moisture content at time of dressing.

G. Face Surface: [**Rough sanded or wire brushed**][**Saw textured**][**Smooth**].

H. Edge Pattern: [**Beaded edge**][**Bullnosed**][**Channel grooved**][**Vee grooved**].

I. Laminating Adhesive: Wet-use type complying with ASTM D2559.

2.4 PRESERVATIVE TREATMENT

A. Pressure treat wood roof decking in accordance with AWPA U1; Use Category UC2.

1. For laminated roof decking, treat lumber before gluing.

B. Preservative Chemicals: [**Inorganic boron (SBX)**][**Acceptable to authorities having jurisdiction and containing no arsenic or chromium**].

1. For exposed items indicated to receive a stained or natural finish, use products that do not contain colorants, bleed through, or otherwise adversely affect finishes.

C. Use process that includes water-repellent treatment.

D. Use process that does not include water repellents or other substances that might interfere with

application of indicated finishes.

E. After treatment, redry materials to [**15**][**19**] percent maximum moisture content.

F. After dressing and fabricating roof decking, apply [**inorganic boron**][**copper naphthenate**] in accordance with AWPA M4 to surfaces cut to a depth of more than **1/16 inch (1.5 mm)**.

2.5 ACCESSORY MATERIALS

A. Fasteners for Solid-Sawn Roof Decking: Provide fastener size and type complying with AITC 112 for thickness of deck used.

B. Fasteners for Glued-Laminated Roof Decking: Provide fastener size and type complying with requirements in "Installation" Article for installing laminated roof decking.

C. Nails: Common; complying with ASTM F1667, Type I, Style 10.

D. Spikes: Round; complying with ASTM F1667, Type III, Style 3.

E. Fastener Material: Hot-dip galvanized steel.

F. Bolts for Anchoring Roof Decking to Walls: Carbon steel; complying with **ASTM A307 (ASTM F568M)** with **ASTM A563 (ASTM A563M)** hex nuts and, where indicated, flat washers[**, all hot-dip zinc coated**].

G. Installation Adhesive: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.

H. Sealants: Latex, complying with applicable requirements in Section 079200 "Joint Sealants" and recommended by sealant manufacturer and manufacturer of substrates for intended application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bostik; Arkema**]
    b. [**May National Associates, Inc.; a subsidiary of Sika Corporation**]
    c. [**Pecora Corporation**]
    d. [**Permathane; a Holcim brand**]
    e. [**Tremco Incorporated**]

I. Penetrating Sealer: Clear sanding sealer complying with Section 099300 "Staining and Transparent Finishing" and compatible with topcoats specified for use over it.

2.6 FABRICATION

A. Shop Fabrication: Where preservative-treated roof decking is indicated, complete cutting, trimming, surfacing, and sanding before treating.

B. Predrill roof decking for lateral spiking to adjacent units to comply with AITC 112.

C. Seal Coat: After fabricating and surfacing roof decking, apply a saturation coat of penetrating sealer[**in fabrication shop**].

D. Apply indicated finish materials to comply with Section 099300 "Staining and Transparent Finishing" in fabrication shop.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and support framing in areas to receive wood roof decking for compliance with installation tolerances and other conditions affecting performance of wood roof decking.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install solid-sawn wood roof decking to comply with AITC 112.

1. Locate end joints for [**two-span continuous lay-up**][**combination simple and two-span continuous lay-up**][**controlled random lay-up**][**lay-up indicated**].

B. Install laminated wood roof decking to comply with manufacturer's written instructions.

1. Locate end joints for [**two-span continuous lay-up**][**combination simple and two-span continuous lay-up**][**controlled random lay-up**][**lay-up indicated**].
2. Nail each course of glued-laminated wood roof decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.

    a. Use 12d nails for 2-by-6 and 2-by-8 roof decking.
    b. Use 30d nails for 3-by-6 and 3-by-8 roof decking.
    c. Use 60d nails for 4-by-6 and 4-by-8 roof decking. Predrill roof decking to prevent splitting.
    d. Use 30d tongue nails in bottom tongue and **3/8-inch (10-mm)** face spikes for 5-by-6 and 5-by-8 roof decking. Predrill roof decking at spikes to prevent splitting.

3. Slant nail each course of glued-laminated wood roof decking to the tongue of the adjacent course at **30 inches (750 mm)** o.c. and within **12 inches (300 mm)** of the end of each unit. Stagger nailing **15 inches (380 mm)** in adjacent courses.

    a. Use 6d nails for 2-by-6 and 2-by-8 roof decking.
    b. Use 8d nails for 3-by-6 and 3-by-8 roof decking.
    c. Use 10d nails for 4-by-6 and 4-by-8 roof decking.
    d. Use 16d nails for 5-by-6 and 5-by-8 roof decking.

4. Glue adjoining roof decking courses together by applying a **3/8-inch (10-mm)** bead of adhesive to the top of tongues, according to research/evaluation report.

C. Anchor wood roof decking, where supported on walls, with bolts as indicated.

D. Where preservative-treated roof decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

1. For solid-sawn roof decking, use inorganic boron (SBX).
2. For laminated roof decking, use copper naphthenate.

E. Apply joint sealant to seal roof decking at exterior walls at the following locations:

1. Between roof decking and supports located at exterior walls.
2. Between roof decking and exterior walls that butt against underside of roof decking.
3. Between tongues and grooves of roof decking over exterior walls and supports at exterior walls.

3.3 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged roof decking if repairs are not approved by Architect, as directed by the Owner.

3.4 PROTECTION

A. Provide water-resistive barrier over roof decking as the Work progresses to protect roof decking until roofing is applied.

B. If, despite protection, [**inorganic boron (SBX)-treated**] roof decking becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 15 00 00

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SECTION 06 15 00 00A - WOOD PATIO DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood decking.
2. Wood stair treads.
3. Wood railings.
4. Wood benches.
5. Plastic decking.

B. Related Requirements:

1. Section 072500 "Weather Barriers" for flexible flashing used with patio decking.
2. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing used with patio decking.

1.2 DEFINITIONS

A. Boards: Lumber of less than **2 inches nominal (38 mm actual)** in thickness and **2 inches nominal (38 mm actual)** or greater in width.

B. Dimension Lumber: Lumber of **2 inches nominal (38 mm actual)** or greater but less than **5 inches nominal (114 mm actual)** in least dimension.

C. Timber: Lumber of **5 inches nominal (114 mm actual)** or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For [**preservative-treated wood products**][**plastic decking**][**and**][**metal framing anchors**].

1. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. For [**plastic decking**][**and**][**metal framing anchors**]. Include installation instructions.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point

of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Samples: For plastic decking, not less than **24 inches (600 mm)** long, showing the range of variation to be expected in appearance of decking, including surface texture.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.[**For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.**]

B. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

C. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood products.
2. Plastic decking.
3. Expansion anchors.
4. Metal framing anchors.
5. Decking fasteners.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

B. Handle and store plastic lumber to comply with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.

1. Factory mark each item with grade stamp of grading agency.
2. For items that are exposed to view in the completed Work, [**mark grade stamp on end or back of each piece**][**or**][**omit grade stamp and provide certificates of grade compliance issued by grading agency**].
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Provide dressed lumber, S4S, unless otherwise indicated.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to

FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

L. Maximum Moisture Content:

1. Boards: [**15**][**19**] percent.
2. Dimension Lumber: [**15 percent**][**19 percent**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**][**19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**].
3. Timber. [**19 percent**][**No limit**].

2.2 WOOD DECKING

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Dimension Lumber Decking:

1. [**No. 2**][**Construction or No. 2**] grade and[**any of**] the following species:

   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.

2. [**Deck Heart or Construction Heart**][**Deck Common or Construction Common**] redwood; RIS.

C. Radius-Edged Board Decking: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir-larch or Douglas fir-south, [**Patio 1**][**Patio 2**]; WWPA.
2. Douglas fir-larch, [**Select Dex**][**Commercial Dex**]; WCLIB.
3. Douglas fir-larch (North), [**Select Patio**][**Commercial Patio**]; NLGA.
4. Hem-fir, [**Patio 1**][**Patio 2**]; WWPA.
5. Hem-fir, [**Select Dex**][**Commercial Dex**]; WCLIB.
6. Hem-fir (North), [**Select Patio**][**Commercial Patio**]; NLGA.
7. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
8. Southern pine, [**Premium**][**Standard**]; SPIB.
9. Western red cedar, [**Patio 1**][**Patio 2**]; WWPA.

10. Western red cedar, [**Select Dex**][**Commercial Dex**]; WCLIB.
11. Western red cedar (North), [**Select Patio**][**Commercial Patio**]; NLGA.

D. S4S Board Decking: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness radius-edged, with one face free of planer skip, machine burn, and torn or chipped grain.

1. Species: [**Ipe**][**Teak**][**Cumaru**][**Garapa**][**Goncalo alves**].
2. Grade Characteristics:

    a. Clear[**one face; small pin knots and worm holes allowed on back face**].
    b. Sound; small pin knots, worm holes, and fixed knots allowed.
    c. All heart[**one face**].
    d. Straight grained and parallel cut.
    e. Free of heart centers.
    f. No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
    g. No discoloration.

2.3 WOOD STAIR TREADS

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Radius-Edged Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir-larch or Douglas fir-south, [**Patio 1**][**Patio 2**]; WWPA.
2. Douglas fir-larch, [**Select Dex**][**Commercial Dex**]; WCLIB.
3. Douglas fir-larch (North), [**Select Patio**][**Commercial Patio**]; NLGA.
4. Hem-fir, [**Patio 1**][**Patio 2**]; WWPA.
5. Hem-fir, [**Select Dex**][**Commercial Dex**]; WCLIB.
6. Hem-fir (North), [**Select Patio**][**Commercial Patio**]; NLGA.
7. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
8. Southern pine, [**Premium**][**Standard**]; SPIB.
9. Western red cedar, [**Patio 1**][**Patio 2**]; WWPA.
10. Western red cedar, [**Select Dex**][**Commercial Dex**]; WCLIB.
11. Western red cedar (North), [**Select Patio**][**Commercial Patio**]; NLGA.

C. Half-Round or Rounded-Edged Nosing Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, [**Edge Grain B & B stepping**][**Near Rift B & B stepping**][**B & B stepping**]; SPIB.

D. S4S Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness radius-edged, with one face free of planer skip, machine burn, and torn or chipped grain.

1. Species: [**Ipe**][**Teak**][**Cumaru**][**Garapa**][**Goncalo alves**].
2. Grade Characteristics:

    a. Clear[**one face; small pin knots and worm holes allowed on back face**].
    b. Sound; small pin knots, worm holes, and fixed knots allowed.
    c. All heart[**one face**].
    d. Straight grained and parallel cut.

e. Free of heart centers.
f. No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
g. No discoloration.

2.4 WOOD RAILINGS

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Dimension Lumber Railing Members:

1. [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**] grade and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

2. [**Heart Clear**][**Heart B or Select Heart**] redwood; RIS.

C. Railing Boards:[**Any of the following species and grades:**]

1. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, B & B finish; SPIB.

D. Radius-Edged Railing Boards: [**Ipe**][**Teak**] S4S boards, [**same grade as decking**][**clear**][**clear all heart**][**, straight grained and parallel cut**].

2.5 WOOD BENCHES

A. Dimension Lumber for Benches:

1. [**Select Structural**][**No. 1**] grade and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

2. [**Heart Clear**][**Heart B or Select Heart**] redwood; RIS.

B. Boards for Benches:[**Any of the following species and grades:**]

1. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, [**Edge Grain B & B finish**][**Near Rift B & B finish**][**B & B finish**]; SPIB.

C. Radius-Edged Boards for Benches: [**Ipe**][**Teak**] S4S boards, [**same grade as decking**][**clear**][**clear all heart**][**, straight grained and parallel cut**].

2.6 DIMENSION LUMBER FRAMING

A. Deck and Stair Framing:

1. [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] grade and[**any of**] the following species:

   a. Hem-fir (North); NLGA.
   b. Southern pine; SPIB.
   c. Douglas fir-larch; WCLIB or WWPA.
   d. Mixed southern pine; SPIB.
   e. Spruce-pine-fir; NLGA.
   f. Douglas fir-south; WWPA.
   g. Hem-fir; WCLIB or WWPA.
   h. Douglas fir-larch (North); NLGA.
   i. Spruce-pine-fir (South); NeLMA, WCLIB, or WWPA.

2. Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.

2.7 POSTS

A. Dimension Lumber Posts: [**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] grade and[**any of**] the following species:

1. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
2. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
3. Mixed southern pine; SPIB.
4. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.
5. Northern species; NLGA.
6. Eastern softwoods; NeLMA.
7. Western woods; WCLIB or WWPA.

B. Timber Posts:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); [**No. 1**][**No. 2**]; NeLMA, NLGA, SPIB, WCLIB, or WWPA.
2. Alaska cedar; [**No. 1**][**No. 2**]; WCLIB.
3. Southern pine; [**No. 1**][**No. 2**]; SPIB.

C. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200, with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

2.8 PRESERVATIVE-TREATED LUMBER

A. Pressure treat boards and dimension lumber with waterborne preservative in accordance with AWPA U1; Use Category UC3b[**for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground**].

B. Pressure treat timber with waterborne preservative in accordance with AWPA U1; Use Category UC4a.

C. Pressure treat poles with waterborne preservative in accordance with AWPA U1; Use Category UC4a.

D. Preservative Chemicals: Acceptable to authorities having jurisdiction.

1. Do not use chemicals containing arsenic or chromium [**except for timber posts**][**except for poles**].

E. Use process[**for boards and dimension lumber**] that includes water-repellent treatment.

F. Use process[**for boards and dimension lumber**] that does not include water repellents or other substances that might interfere with application of indicated finishes.

G. After treatment, redry [**boards**][**dimension lumber**][**timber**][**and**][**poles**] to 19 percent maximum moisture content.

H. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For items indicated to receive a stained or natural finish, [**mark each piece on surface that will not be exposed**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

I. Application: [**Treat all wood unless otherwise indicated.**][**Treat items indicated on Drawings and the following:**]

1. Framing members[**less than 18 inches (460 mm) above grade**].
2. Sills and ledgers.
3. Members in contact with masonry or concrete.
4. Posts.
5. Round wood poles.
6. Decking.
7. Stair treads.

2.9 PLASTIC DECKING

A. Plastic Lumber, General: Products acceptable to authorities having jurisdiction with current model code evaluation reports that show compliance with building code in effect for Project for indicated type of construction.

1. Allowable loads and spans, as documented in evaluation reports or in information referenced in evaluation reports, are not to be less than design loads and spans indicated.

B. Composite Plastic Lumber: [**Solid**][**or**][**hollow**] shapes made from a mixture of cellulose fiber and polyethylene or polypropylene.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Fiberon**]
    c. [**Green Bay Decking, LLC**]
    d. [**Midwest Manufacturing**]
    e. [**MoistureShield; Oldcastle APG, Inc., CRH Americas, Inc.**]
    f. [**NewTechWood America, Inc.**]
    g. [**TimberTech, AZEK Building Products; The AZEK Company LLC**]
    h. [**Trex Company, Inc.**]
    i. [**UFP Construction; a UFP Industries Company**]

2. Decking Standard: [**ICC-ES AC109**][**or**][**ICC-ES AC174**].
3. Decking Size: [**7/8 by 5-1/2 inches (22 by 140 mm) actual**][**1-1/4 by 6 nominal, 1 by 5-1/2 inches (25 by 140 mm) actual**][**1-1/2 by 6 nominal, 1-1/4 by 5-1/2 inches (32 by 140 mm) actual**][**1-1/4 by 6 inches (32 by 152 mm) actual**][**1-3/8 by 3-1/2 inches (35 by 89 mm) actual**][**1-3/8 by 5-1/2 inches (35 by 140 mm) actual**][**2 by 6 nominal, 1-1/2 by 5-1/2 inches (38 by 140 mm) actual**].
4. Configuration: Provide product with grooved edges designed for fastening with concealed decking fasteners.
5. Surface Texture: [**Woodgrain**][**Smooth**][**Manufacturer's standard**].
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

C. All-Plastic Lumber: [**Solid**][**or**][**hollow**] shapes made from high-density polyethylene (HDPE), PVC, polystyrene, or cellular PVC with no cellulose fiber.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Genova Products, Inc.**]
    c. [**Interplast Group, Ltd.**]
    d. [**L.B. Plastics, Inc.**]
    e. [**Re-Plast Products, Inc.**]
    f. [**RENEW Plastics, a division of N.E.W. Plastics Corp**]
    g. [**Veka Inc.**]
    h. [**Westech**]

2. Decking Standard: ICC-ES AC174.
3. Decking Size: [**1 by 6 inches (25 by 152 mm) actual**][**1-1/4 by 6 nominal, 1 by 5-1/2 inches (25 by 140 mm) actual**][**1-1/2 by 6 nominal, 1-1/4 by 5-1/2 inches (32 by 140 mm) actual**][**2 by 4 nominal, 1-1/2 by 3-1/2 inches (38 by 89 mm) actual**][**2 by 6 nominal, 1-1/2 by 5-1/2 inches (38 by 140 mm) actual**][**1-5/8 by 5-3/4 inches (41 by 146 mm) actual**].
4. Configuration: Provide product with [**grooved edges designed for fastening with concealed decking fasteners**][**or**][**tongue-and-groove edges designed for concealed fastening**].
5. Surface Texture: [**Woodgrain**][**Smooth**][**Manufacturer's standard**].
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.10 FASTENERS

A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.

1. Use [**stainless steel**][**fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329**] unless otherwise indicated.
2. For pressure-preservative-treated wood, use stainless steel fasteners.
3. For [**plastic**][**wood**] decking, use stainless steel fasteners[**where fasteners are exposed to view**].
4. For redwood, use [**brass/bronze**][**stainless steel**][**hot-dip galvanized-steel**] fasteners.

B. Nails: ASTM F1667.

C. Power-Driven Fasteners: ICC-ES AC70.

D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.

E. Carbon-Steel Bolts: **ASTM A307 (ASTM F568M)** with **ASTM A563 (ASTM A563M)** hex nuts and, where indicated, flat washers all hot-dip zinc coated.

F. Stainless Steel Bolts: **ASTM F593, Alloy Group 1 or 2 (ASTM F738M, Grade A1 or Grade A4)**; with **ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or Grade A4)** hex nuts and, where indicated, flat washers.

G. Postinstalled Anchors: Stainless steel, [**chemical**][**or**][**torque-controlled expansion**] anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing in accordance with ASTM E488 conducted by a qualified independent testing and inspecting agency.

1. Stainless steel bolts and nuts complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or Grade A4)**.

2.11 METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Tamlyn**]
2. [**USP Structural Connectors**]

B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those [**indicated on Drawings**][**of products of manufacturers listed**]. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, [**G60 (Z180)**][**G90 (Z270)**][**G185 (Z550)**] coating designation.

D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].

E. Joist Hangers: U-shaped, with **2-inch- (50-mm-)** long seat and **1-1/4-inch- (32-mm-)** wide nailing flanges at least 85 percent of joist depth.

1. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].

F. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.

1. Strap Width: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**].
2. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].

G. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post **1 inch (25 mm)** above base and with **2-inch- (50-mm-)** minimum side cover, socket **0.062 inch (1.6 mm)** thick, and standoff and adjustment plates **0.108 inch (2.8 mm)** thick.

H. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

1. Width: [**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**].
2. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].
3. Length: [**16 inches (400 mm)**][**24 inches (600 mm)**][**As indicated**].

2.12 CONCEALED DECKING FASTENERS

A. Deck Splines: Corrosion-resistant metal or plastic splines that fit in grooves routed into the sides of decking material and are fastened to deck framing with screws. Splines provide uniform spacing of decking material.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Grabber Construction Products, Inc.**]
b. [**Ipe Clip Fastener Company Inc. (The)**]
c. [**M. M. Products, Inc.**]
d. [**Titan Metal Werks, Inc.**]

B. Deck Clips: Black-oxide-coated, stainless steel clips designed to be fastened to deck framing with screws, and to secure decking material with teeth that also provide uniform spacing of decking material.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**FastenMaster; a division of OMG, Inc.**]

C. Deck Tracks: Formed metal strips designed to be fastened to deck framing and to secure decking material from underside with screws. Made from epoxy-powder-coated, hot-dip galvanized steel or stainless steel.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Grabber Construction Products, Inc.**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Prime wood[**indicated to be painted**], including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Section 099113 "Exterior Painting."

C. Stain wood[**indicated to be stained**], including both faces and edges. Cut to required lengths and stain ends. Comply with requirements in Section 099300 "Staining and Transparent Finishing."

3.3 INSTALLATION, GENERAL

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.

B. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.

C. Install wood decking[**and stair treads**] with crown up (bark side down).

D. Install plastic lumber to comply with manufacturer's written instructions.

E. Secure decking to framing with [**deck splines**][**deck clips**][**deck tracks**][**or**][**screws**].

F. Install metal framing anchors to comply with manufacturer's written instructions.

G. Do not splice structural members between supports unless otherwise indicated.

H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

I. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

J. Apply copper naphthenate field treatment to comply with AWPA M4, to cut surfaces of preservative-treated lumber.

K. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. ICC-ES AC70 for power-driven fasteners.
2. "Fastening Schedule" in ICC's International Building Code.
3. "Fastener Schedule for Structural Members" and "Alternate Attachments" in ICC's International Residential Code for One- and Two-Family Dwellings.

L. Use common wire nails unless otherwise indicated. Select fasteners of size that do not fully penetrate members where opposite side is exposed to view. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.

M. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced and with adjacent rows staggered.

3.4 INSTALLATION OF ELEVATED DECK JOIST FRAMING

A. General: Install joists with crown edge up and support ends of each member with not less than **1-1/2 inches (38 mm)** of bearing on wood or metal, or **3 inches (76 mm)** on masonry. Attach floor joists where framed into wood supporting members by using wood ledgers as indicated or, if not indicated, by using metal joist hangers. Do not notch joists.

B. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds **48 inches (1200 mm)**.

C. Lap members framing from opposite sides of beams or girders not less than **4 inches (102 mm,)** or securely tie opposing members together. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist over supports.

D. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist at intervals of **96 inches (2438 mm)** o.c., between joists.

3.5 INSTALLATION OF STAIRS

A. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:

1. Stringer Size: **2 by 12 inches nominal (38 by 286 mm actual)**, minimum.
2. Notching: Notch stringers to receive treads, risers, and supports; leave at least **3-1/2 inches (89 mm)** of effective depth.
3. Stringer Spacing: At least three stringers for each **36-inch (914-mm)** clear width of stair.

B. Provide stair framing with no more than[**3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than**] **3/8-inch (9.5-mm)** variation between largest and smallest treads and risers within each flight.

C. Treads and Risers: Secure by gluing and [**nailing**][**screwing**] to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages[**and finish with bullnose edge**].

3.6 INSTALLATION OF RAILINGS

A. Balusters: Fit to railings, [**glue, and**][**nail**][**screw**] in place. Countersink fastener heads, fill flush, and sand filler.

B. Newel Posts: Secure to stringers and risers with [**through bolts**][**lag screws**][**countersunk-head wood screws and glue**].

C. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts[**and glue**].

END OF SECTION 06 15 00 00A

Task	Specification	Specification Description
06 15 13 00	06 10 00 00	Rough Carpentry
06 15 13 00	06 15 00 00	Wood Roof Decking
06 15 13 00	06 15 00 00a	Wood Patio Decking

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SECTION 06 16 00 00 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.
3. Parapet sheathing.
4. Composite nail base insulated roof sheathing.
5. Subflooring.
6. Underlayment.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for plywood backing panels.
2. Section 072500 "Weather Barriers" for water-resistive barrier applied over wall sheathing.

1.2 DEFINITIONS

A. ABAA: The Air Barrier Association of America.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical

data and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.

1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

C. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.
4. Product Data: For installation adhesives, indicating VOC content.
5. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer [**including list of ABAA-certified installers and supervisors employed by Installer, who work on Project**][**and**][**testing and inspecting agency**] .

B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

D. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated plywood.
2. Fire-retardant-treated plywood.
3. Foam-plastic sheathing.
4. Air-barrier and water-resistant glass-mat gypsum sheathing.
5. Power-driven fasteners.

E. Field Quality Control Reports: For specified tests and inspections.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.

1. Installer is to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and is to employ ABAA-certified installers and supervisors on Project.

B. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing meeting the requirements as follows:

    a. Independent agency, qualified in accordance with ASTM E329 for testing indicated, and certified by ABAA.

C. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.7 MOCKUPS

A. Build mockups to set quality standards for materials and execution [**and for preconstruction testing**], as directed by the Owner .

1. Build integrated mockups of exterior wall assembly [**as indicated on Drawings**][**150 sq. ft. (14 sq. m)**] , incorporating backup wall construction, window, storefront, door frame and sill, ties and other penetrations, and flashing to demonstrate crack and joint treatment and sealing of gaps, terminations, and penetrations of air-barrier sheathing assembly.

    a. Coordinate construction of mockups to permit inspection and testing of sheathing before external insulation and cladding are installed.
    b. Include junction with roofing membrane [**building corner condition,**][**and**][**foundation wall intersection**] .
    c. If Architect determines mockups do not comply with requirements, reconstruct mockups until mockups are approved, as directed by the Owner.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on field mockups, as directed by the Owner.

B. Mockup Testing: Air-barrier and water-resistant glass-mat gypsum sheathing assemblies are to comply with performance requirements, as evidenced by reports based on mockup testing by a qualified testing agency.

1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage in accordance with [**ASTM E1186, chamber pressurization or depressurization with smoke tracers**][**ASTM E1186, chamber depressurization with detection liquids**] .
2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate in accordance with [**ASTM E783**][**or**][**ASTM E2357**] .
3. Notify Architect [**seven**] days in advance of the dates and times when mockups will be tested, as directed by the Owner.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, are to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies are to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations [**tie-ins to installed waterproofing**][**tie-ins to other installed air barriers**] , and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.2 WOOD STRUCTURAL PANEL PRODUCTS

A. General: Wood structural panels include plywood, mat-formed (nonveneer) panels such as oriented strand board, and composite panels, which are veneer-faced panels with mat-formed cores.

B. Emissions: Products are to meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Certified Wood: Verify the following wood products are certified as "FSC Pure" [**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

D. Certified Wood: Verify the following wood products are labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

E. Certified Wood: Verify the following wood products are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

F. Thickness: As needed to comply with requirements specified, but not less than thickness indicated on Drawings.

G. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative-Treated Plywood by Pressure Process: AWPA U1, use categories as follows:

1. UC2, Interior/Damp: For interior construction not in contact with ground but may be subject to moisture.
2. UC3B, Above Ground, Exposed: For exterior construction not in contact with ground, exposed to all weather cycles including prolonged wetting.
3. UC4A, Ground Contact: For wood panels in contact with ground and exposed to all weather cycles, normal exposure conditions.
4. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: [**Treat all plywood unless otherwise indicated**][**Treat items indicated on Drawings**][**and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing**] .

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 ft.** **(3.2 m)** beyond the centerline of the burners at any time during the test.

1. Treatment must not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated on Drawings.
3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber plywood is to be tested in accordance with ASTM D5516 and design value adjustment factors are to be calculated in accordance with ASTM D6305. Span ratings after treatment are to be not less than span ratings specified. [**For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) are to be not less than span ratings specified.**]

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: [**Treat all plywood unless otherwise indicated.**][**Treat plywood indicated on Drawings, and the following:**]

1. Roof [**and wall**] sheathing within **48 inches (1220 mm)** of [**fire**][**party**] walls.
2. Roof sheathing.
3. Subflooring and underlayment for raised platforms.

2.5 WALL SHEATHING

A. Plywood Sheathing, Walls:

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**] .
3. Nominal Thickness: Not less than [**11/32 inch (8.7 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Walls:

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**] .
3. Nominal Thickness: Not less than [**5/16 inch (7.9 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] .

C. Paper-Surfaced Gypsum Sheathing: ASTM C1396/C1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**American Gypsum**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Georgia-Pacific Gypsum LLC**]
    d. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Edge and End Configuration: [**V-shaped, tongue-and-groove long edges; square ends**][**Square**] .
4. Size: [**24 by 96 inches (610 by 2438 mm) for horizontal**][**48 by 96 inches (1219 by 2438 mm) for vertical**][**48 by 108 inches (1219 by 2743 mm) for vertical**][**600 by 2400 mm for horizontal**][**1200 by 2400 mm for vertical**][**1200 by 2750 mm for vertical**] installation.

D. Glass-Mat Gypsum Sheathing, Walls: ASTM C1177/C1177M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Continental Building Products Inc.**]
    c. [**Georgia-Pacific Gypsum LLC**]
    d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    e. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.

E. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, coated fiberglass mat gypsum sheathing with integral weather-resistant barrier and air barrier complying with ASTM E2178.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Georgia-Pacific Gypsum LLC**]
    b. [**Tremco Commercial Sealants and Waterproofing, part of Tremco CPG**]
    c. [**USG Corporation**]

2. Thickness: **5/8 inch (15.9 mm)** thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.
4. Edges: Square.
5. Flashing and Transitions Strips: As acceptable to sheathing manufacturer.
6. Air Permeance: Maximum [**0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa)**] pressure difference when tested in accordance with ASTM E2178.
7. Vapor Permeance: Minimum [**20 perms (580 ng/Pa x s x sq. m)**] when tested in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.
8. Sheathing Assembly Air Leakage: Maximum [**0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa)**] when tested in accordance with ASTM E2357.
9. Fire Propagation Characteristics: Complies with NFPA 285 testing as part of an approved assembly.
10. UV Resistance: Can be exposed to sunlight for [**30**][**90**][**180**] days in accordance with manufacturer's written instructions.
11. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by sheathing manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

F. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C1278/C1278M, gypsum sheathing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] .

G. Cementitious Backer Units, Walls: ASTM C1325, Type A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**C-Cure**]
   b. [**Custom Building Products**]
   c. [**FinPan, Inc.**]
   d. [**USG Corporation**]

2. Thickness: [**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**] .

H. Fiberboard Sheathing: ASTM C208, Type IV, cellulosic fiberboard sheathing with square edges.

1. Grade: [**1 (Regular)**][**2 (Structural)**] .
2. Thickness: [**1/2 inch (13 mm)**][**25/32 inch (20 mm)**] .

I. Extruded-Polystyrene-Foam Sheathing: ASTM C578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**DiversiFoam Products**]
   b. [**HydroBlok**]
   c. [**Kingspan Insulation LLC**]
   d. [**Owens Corning**]
   e. [**The Dow Chemical Company**]

2. Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**] .
3. Flame Propagation Test: Materials and construction are to be tested in accordance with NFPA 285.

J. Foil-Faced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type I or Type II, Class 2, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings are to have a flame-spread index of

25 or less when tested individually.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Carlisle Coatings & Waterproofing Inc**]
    c. [**Elevate; Amrize Building Envelope LLC**]
    d. [**Hunter Panels; a Carlisle Company**]
    e. [**Rmax, A Business Unit of Sika Corporation**]
    f. [**The Dow Chemical Company**]

2. Thickness: [**7/16 inch (11.1 mm)**][**1/2 inch (13 mm)**][**5/8 inch (15.9 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**] .
3. Flame Propagation Test: Materials and construction are to be tested in accordance with NFPA 285.

2.6 ROOF SHEATHING

A. Plywood Sheathing, Roofs :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Roofs :

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**7/16 inch (11.1 mm)**][**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] .

2.7 PARAPET SHEATHING

A. Plywood Sheathing, Parapets :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Parapets :

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**7/16 inch (11.1 mm)**][**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] .

C. Glass-Mat Gypsum Roof Boards, Parapets: ASTM C1177/C1177M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.

D. Cementitious Backer Units, Parapets: ASTM C1325, Type A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**C-Cure**]
    b. [**Custom Building Products**]
    c. [**FinPan, Inc.**]
    d. [**USG Corporation**]

2. Thickness: [**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**] .

2.8 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type V with DOC PS 2, Exposure 1 oriented strand board on one face.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Cornell Performance Building Products, a Subsidiary of GAF**]
    c. [**Hunter Panels; a Carlisle Company**]
    d. [**Johns Manville; a Berkshire Hathaway company**]
    e. [**Rmax, A Business Unit of Sika Corporation**]
    f. [**The Dow Chemical Company**]

2. Polyisocyanurate-Foam Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**] .
3. Oriented-Strand-Board Nominal Thickness: [**7/16 inch (11.1 mm)**][**5/8 inch (15.9 mm)**] .

B. Vented, Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type II,

Class 1, with DOC PS 2, Exposure 1 oriented strand board adhered to spacers on one face.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Cornell Performance Building Products, a Subsidiary of GAF**]
    c. [**Hunter Panels; a Carlisle Company**]
    d. [**Johns Manville; a Berkshire Hathaway company**]
    e. [**Rmax, A Business Unit of Sika Corporation**]
    f. [**The Dow Chemical Company**]

2. Polyisocyanurate-Foam Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**] .
3. Oriented-Strand-Board Nominal Thickness: [**7/16 inch (11.1 mm)**][**5/8 inch (15.9 mm)**] .
4. Spacers: Wood furring strips or blocks not less than **3/4 inch (19 mm)** thick and spaced not more than [**12 inches (300 mm)**][**16 inches (400 mm)**][**24 inches (600 mm)**] o.c.

2.9 SUBFLOORING

A. Plywood Combination Subfloor-Underlayment :

1. Classification: DOC PS 1, [**Exterior, Structural I, C-C Plugged**][**Exterior, C-C Plugged**][**Exposure 1, Structural I, Underlayment**][**Exposure 1, Underlayment**] single-floor panels.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .
4. Edge Detail: [**Square**][**Tongue and groove**] .
5. Surface Finish: Fully sanded face.

B. Oriented-Strand-Board Combination Subfloor-Underlayment :

1. Classification: DOC PS 2, Exposure 1 single-floor panels.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .
4. Edge Detail: [**Square**][**Tongue and groove**] .
5. Surface Finish: [**Fully sanded**][**Resin-impregnated overlay**] face.

C. Plywood Subflooring :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] single-floor panels or sheathing.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**][**or**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .

D. Oriented-Strand-Board Subflooring :

1. Classification: DOC PS 2, Exposure 1 [**Structural I sheathing**][**single-floor panels or sheathing**] .
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**][**or**][**32/16**][**40/20**][**48/24**][**60/32**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .

2.10 UNDERLAYMENT

A. General: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than **1/4 inch (6.4 mm)** over smooth subfloors and not less than **3/8 inch (9.5 mm)** over board or uneven subfloors.

B. Plywood Underlayment for Resilient Flooring :

1. Classification: DOC PS 1, [**Exterior A-C**][**Exterior B-C**][**Exterior, C-C Plugged**][**Exposure 1 Underlayment**] with fully sanded face.

C. Plywood Underlayment for Ceramic Tile :

1. Classification: DOC PS 1, Exterior, C-C Plugged, not less than **5/8-inch (15.9-mm)** nominal thickness.

D. Plywood Underlayment for Carpet :

1. Classification: DOC PS 1, [**Exterior, C-C Plugged**][**Exposure 1, Underlayment**][**Interior, Underlayment**] .

E. Particleboard Underlayment : ANSI A208.1, [**Grade PBU**][**Grade M-2**] .

1. Verify particleboard is made without urea formaldehyde.
2. Verify particleboard has formaldehyde emission rates not greater than 0.09 ppm when tested in accordance with ASTM D6007 or ASTM E1333.

F. Hardboard Underlayment : ANSI A135.4, Class 4 (Service), Surface S1S; with back side sanded.

2.11 MISCELLANEOUS MATERIALS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacturer.

1. For [**roof**][**parapet**][**and**][**wall**] sheathing, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M**][**of Type 304 stainless steel**] .
2. For [**roof**][**parapet**][**and**][**wall**] sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended in writing by screw manufacturer for material being fastened.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended in writing by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than **0.0329 inch (0.835 mm)** thick, use screws that comply with ASTM C1002.
2. For steel framing from **0.033 to 0.112 inch (0.84 to 2.84 mm)** thick, use screws that comply with ASTM C954.

G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended in writing by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

H. Sealant for Paper-Surfaced and Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended in writing by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."

I. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended in writing by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum **2 inches (50 mm)** wide, **10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m)**, of type recommended in writing by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

J. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended in writing by sheathing manufacturer for sealing joints and penetrations in sheathing.

K. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with [**APA AFG-01**][**ASTM D3498**] that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

1. Verify adhesive has a VOC content of [**50**][**70**] g/L or less.
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in the ICC's "International Building Code."
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's "International Residential Code for One- and Two-Family Dwellings."
3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate [**wall**][**parapet**][**and**][**roof**] sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 INSTALLATION OF WOOD STRUCTURAL PANELS

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:

1. Combination Subfloor-Underlayment:

a. [**Glue and nail**][**Nail**] to wood framing.
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

2. Subflooring:

a. [**Glue and nail**][**Nail**][**Nail or staple**] to wood framing.
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

3. Wall and Roof Sheathing:

a. [**Nail**][**Nail or staple**] to wood framing. [**Apply a continuous bead of glue to framing members at edges of wall sheathing panels.**]
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

4. Underlayment:

a. [**Nail**][**Nail or staple**] to subflooring.

b. Space panels **1/32 inch (0.8 mm)** apart at edges and ends.
c. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.

3.3 INSTALLATION OF GYPSUM SHEATHING

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to wood framing with [**nails**][**or**][**screws**] .
2. Fasten gypsum sheathing to cold-formed metal framing with screws.
3. Install panels with a **3/8-inch (9.5-mm)** gap where non-load-bearing construction abuts structural elements.
4. Install panels with a **1/4-inch (6.4-mm)** gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately **8 inches (200 mm)** o.c. and set back a minimum of **3/8 inch (9.5 mm)** from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately **8 inches (200 mm)** o.c. and set back a minimum of **3/8 inch (9.5 mm)** from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

E. Seal sheathing joints in accordance with sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.4 INSTALLATION OF AIR-BARRIER AND WATER-RESISTANT GLASS-MAT GYPSUM SHEATHING

A. Install accessory materials in accordance with sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.

1. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

2. Install transition strip on roofing membrane or base flashing, so that a minimum of **3 inches (75 mm)** of coverage is achieved over each substrate.

B. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

D. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply [**transition strip**][**preformed silicone extrusion**] , so that a minimum of **3 inches (75 mm)** of coverage is achieved over each substrate. Maintain **3 inches (75 mm)** of full contact over solid bearing to perimeter frames, with not less than **1 inch (25 mm)** of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.
2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

E. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.

F. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

G. Seal top of through-wall flashings to sheathing with an additional **6-inch- (150-mm-)** wide transition strip.

H. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

I. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending **6 inches (150 mm)** beyond repaired areas in strip direction.

3.5 INSTALLATION OF CEMENTITIOUS BACKER UNITS

A. Install panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.6 INSTALLATION OF FIBERBOARD SHEATHING

A. Comply with ASTM C846 and with manufacturer's written instructions.

B. Fasten fiberboard sheathing panels to intermediate supports and then at edges and ends. Use galvanized roofing nails [**or galvanized staples**] ; comply with manufacturer's recommended spacing and referenced fastening schedule. Drive fasteners flush with surface of sheathing and locate perimeter fasteners at least **3/8 inch (9.5 mm)** from edges and ends.

C. Install sheathing vertically with long edges parallel to, and centered over, studs. Install solid wood blocking where end joints do not occur over framing. Allow **1/8-inch (3-mm)** open space between edges

and ends of adjacent units. Stagger horizontal joints if any.

D. Cover sheathing as soon as practical after installation to prevent deterioration from wetting.

3.7 INSTALLATION OF FOAM-PLASTIC SHEATHING

A. Comply with manufacturer's written instructions.

B. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of moisture vapor that otherwise would be trapped in stud cavity behind sheathing.

C. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

3.8 INSTALLATION OF PARTICLEBOARD UNDERLAYMENT

A. Comply with CPA's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.

1. Fastening Method: [**Glue and nail**][**Nail**][**Nail or staple**] underlayment to subflooring.

3.9 INSTALLATION OF HARDBOARD UNDERLAYMENT

A. Comply with CPA's recommendations and hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.

1. Fastening Method: [**Nail**][**Nail or staple**] underlayment to subflooring.

3.10 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing and Inspecting Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. [**Inspections may include the following:**]

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
3. Termination mastic has been applied on cut edges.
4. Strips and transition strips have been firmly adhered to substrate.
5. Compatible materials have been used.
6. Transitions at changes in direction and structural support at gaps have been provided.
7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
8. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage in accordance with [**ASTM E1186, chamber pressurization or depressurization with smoke tracers**][**ASTM E1186, chamber depressurization using detection liquids**] .
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with [**ASTM E783**][**or**][**ASTM E2357**] .

E. Air barriers will be considered defective if they do not pass tests and inspections.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

END OF SECTION 06 16 00 00

Task	Specification	Specification Description
06 16 23 00	06 10 00 00	Rough Carpentry
06 16 23 00	06 16 00 00	Sheathing
06 16 33 00	06 10 00 00	Rough Carpentry
06 16 33 00	06 16 00 00	Sheathing
06 16 43 00	06 10 00 00	Rough Carpentry
06 16 43 00	06 16 00 00	Sheathing
06 17 13 00	06 10 00 00	Rough Carpentry
06 17 13 00	06 18 00 00	Glued-Laminated Construction
06 17 23 00	06 10 00 00	Rough Carpentry
06 17 43 00	06 10 00 00	Rough Carpentry
06 17 43 00	06 18 00 00	Glued-Laminated Construction

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SECTION 06 17 53 00 - SHOP-FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood products.
2. Preservative-treated lumber.
3. Fire-retardant-treated lumber.

1.2 ALLOWANCES

A. Provide wood truss bracing under the Metal-Plate-Connected Truss Bracing Allowance as specified in Section 012100 "Allowances."

1.3 DEFINITIONS

A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For [**wood-preservative-treated lumber,**][**fire-retardant-treated lumber,**] metal-plate connectors, metal truss accessories, and fasteners.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification from treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification from treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to truss fabricator.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.

5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Shop Drawings: Show fabrication and installation details for trusses.

1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
2. Indicate sizes, stress grades, and species of lumber.
3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
4. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.
5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
6. Show splice details and bearing details.

D. Delegated Design Submittals: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**metal connector-plate manufacturer**][**professional engineer**][**and**][**fabricator**].

B. Material Certificates: For dimension lumber specified to comply with minimum specific gravity. Indicate species and grade selected for each use and specific gravity.

C. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss-fabricating firm.

D. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated lumber.
2. Fire-retardant-treated wood.
3. Metal-plate connectors.
4. Metal truss accessories.

1.6 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.

1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that [**participates in a recognized quality-assurance program, complies with quality-control procedures in TPI 1, and involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction**][**and**][**is certified for chain of custody by an FSC-accredited certification body**].

C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

D. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

E. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

F. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

G. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in SBCA BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."

1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
3. Provide for air circulation around stacks and under coverings.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-plate-connected wood trusses.

B. Structural Performance: Metal-plate-connected wood trusses are to be capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

1. Design Loads: As indicated.
2. Maximum Deflection under Design Loads:

a. Roof Trusses: Vertical deflection of [**1/180**][**1/240**][**1/360**] of span.
b. Floor Trusses: Vertical deflection of [**1/360**][**1/480**][**1/600**] of span.

C. Comply with applicable requirements and recommendations of TPI 1, TPI DSB, and SBCA BCSI.

D. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

E. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

G. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

H. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

I. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

J. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

K. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

L. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

M. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

N. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 WOOD PRODUCTS

A. Lumber: DOC PS 20 and applicable rules of any rules-writing agency certified by the American Lumber Standard Committee (ALSC) Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.

3. Provide dressed lumber, S4S.
4. Provide dry lumber with [**15**][**19**] percent maximum moisture content at time of dressing.

B. Minimum Chord Size for Roof Trusses: [**2 by 6 inches nominal (38 by 140 mm actual) for top chords**][**2 by 6 inches nominal (38 by 140 mm actual) for bottom chords**][**2 by 6 inches nominal (38 by 140 mm actual) for both top and bottom chords**].

C. Minimum Specific Gravity for Top Chords: [**0.50**].

D. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Section 061000 "Rough Carpentry."

2.3 PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2[**for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground**].

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed trusses indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

D. Application: Treat [**all trusses unless otherwise indicated**][**trusses where indicated on Drawings**].

2.4 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products according to test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201 at 92 percent relative humidity. Use for interior locations

where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber is to be tested in accordance with ASTM D5664, and design value adjustment factors is to be calculated in accordance with ASTM D6841.[**For enclosed roof framing and framing in attic spaces, and where high-temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.**]

C. Kiln-dry lumber after treatment to a maximum moisture content of [**15**][**19**] percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed trusses and bracing indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

E. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat [**all trusses unless otherwise indicated.**][**items indicated on Drawings, and the following:**]

1. Floor trusses.
2. Roof trusses.

2.5 METAL CONNECTOR PLATES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alpine, a division of ITW Inc.**]
2. [**Cherokee Metal Products, Inc.; Masengill Machinery Company**]
3. [**Eagle Metal Products**]
4. [**MiTek Industries, Inc.**]

B. Fabricate connector plates to comply with TPI 1.

C. Hot-Dip Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G60 (Z180)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

1. Use for interior locations unless otherwise indicated.

D. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G185 (Z550)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

1. Use for wood-preservative-treated lumber and where indicated.

E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], and not less than **0.035 inch (0.88 mm)** thick.

1. Use for exterior locations[**, wood-preservative-treated lumber,**][**fire-retardant treated lumber,**] and where indicated.

2.6 FASTENERS

A. Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.
2. Where trusses are exposed to weather, in ground contact, made from pressure-preservative treated wood, or in area of high relative humidity, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M**][**of Type 304 stainless steel**].

B. Nails, Brads, and Staples: ASTM F1667.

2.7 METAL FRAMING ANCHORS AND ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

B. Allowable design loads, as published by manufacturer, are to comply with or exceed those [**indicated**][**of products of manufacturers listed**]. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors are to be punched for fasteners adequate to withstand same loads as framing anchors.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, **G60 (Z180)** coating designation.

1. Use for interior locations unless otherwise indicated.

D. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G185 (Z550)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

1. Use for wood-preservative-treated lumber and where indicated.

E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].

1. Use for exterior locations and where indicated.

F. Truss Tie-Downs: Bent strap tie for fastening roof trusses to wall studs below, **1-1/2 inches (38 mm)** wide by **0.050 inch (1.3 mm)** thick.[**Tie fastens to one side of truss, top plates, and side of stud below.**]

G. Truss Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening roof trusses to wall studs

below, **2-1/4 inches (57 mm)** wide by **0.062 inch (1.6 mm)** thick. Tie fits over top of truss and fastens to both sides of truss, top plates, and one side of stud below.

H. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, **1-1/4 inches (32 mm)** wide by **0.050 inch (1.3 mm)** thick. Clip is fastened to truss through slotted holes to allow for truss deflection.

I. Floor Truss Hangers: U-shaped hangers, full depth of floor truss, with **1-3/4-inch- (44-mm-)** long seat; formed from metal strap **0.062 inch (1.6 mm)** thick with tabs bent to extend over and be fastened to supporting member.

J. Roof Truss Bracing/Spacers: U-shaped channels, **1-1/2 inches (38 mm)** wide by **1 inch (25 mm)** deep by **0.040 inch (1.0 mm)** thick, made to fit between two adjacent trusses and accurately space them apart, and with tabs having metal teeth for fastening to trusses.

K. Drag Strut Connectors: Angle clip with one leg extended for fastening to the side of girder truss.

1. Angle clip is **3 by 3 by 0.179 by 8 inches (76 by 76 by 4.55 by 203 mm)** with extended leg **8 inches (203 mm)** long. Connector has galvanized finish.
2. Angle clip is **3 by 3 by 0.239 by 10-1/2 inches (76 by 76 by 6.07 by 267 mm)** with extended leg **10-1/2 inches (267 mm)** long. Connector has painted finish.

2.8 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 92 percent zinc dust by weight.

2.9 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.

B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.

C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly, with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.

1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

2.10 SOURCE QUALITY CONTROL

A. Special Inspections: the Owner will engage a qualified special inspector to perform special inspections, as directed by the Owner.

1. Provide special inspector with access to fabricator's documentation of detailed fabrication and quality-control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards.

2. Provide special inspector with access to places where wood trusses are being fabricated to perform inspections.

B. Correct deficiencies in Work that special inspections indicate do not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

F. Space trusses [**16 inches (406 mm) o.c.**][**24 inches (610 mm) o.c.**][**as indicated**]; adjust and align trusses in location before permanently fastening.

G. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.

H. Securely connect each truss ply required for forming built-up girder trusses.

1. Anchor trusses to girder trusses as indicated.

I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

1. Install bracing to comply with Section 061000 "Rough Carpentry."
2. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.

J. Install wood trusses within installation tolerances in TPI 1.

K. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.

L. Replace wood trusses that are damaged or do not comply with requirements.

1. Damaged trusses may be repaired according to truss repair details signed and sealed by the qualified professional engineer responsible for truss design, as directed by the Owner.

3.2 REPAIRS AND PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate

solution by spraying to comply with EPA-registered label.

B. Protect wood trusses from weather. If, despite protection, wood trusses become wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

C. Repair damaged galvanized coatings on exposed surfaces in accordance with ASTM A780/A780M and manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Special Inspections: the Owner will engage a qualified special inspector to perform special inspections to verify that temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package, as directed by the Owner.

END OF SECTION 06 17 53 00

SECTION 06 18 00 00 - GLUED-LAMINATED CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural glued-laminated timber.
2. Timber connectors.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with structural glued-laminated timber.
2. Section 061300 "Heavy Timber Construction" for framing using [**timbers**][**and**][**round wood poles**].
3. Section 061516 "Wood Roof Decking" for glued-laminated wood roof decking.

1.2 DEFINITIONS

A. Structural Glued-Laminated (Glulam) Timber: An engineered, stress-rated timber product assembled from selected and prepared wood laminations bonded together with adhesives and with the grain of the laminations approximately parallel longitudinally.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on lumber, adhesives, fabrication, and protection.
2. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
3. For connectors. Include installation instructions.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Product Data: For laminating adhesives, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For laminating adhesives, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For laminating adhesives, indicating compliance with requirements for low-emitting materials.
6. Product Data: For laminating adhesives, indicating that product contains no urea formaldehyde.
7. Product Data: For laminating adhesives, indicating that product contains no urea formaldehyde.

C. Shop Drawings:

1. Show layout of structural glued-laminated timber system and full dimensions of each member.
2. Indicate species and laminating combination.

3. Include large-scale details of connections.

D. Samples: Full width and depth, **24 inches (600 mm)** long, showing the range of variation to be expected in appearance of structural glued-laminated timber[**including variations due to specified treatment**].

1. Apply specified factory finish to three sides of half length of each Sample.

E. Delegated Design Submittal: For structural glued-laminated timber and timber connectors.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in ANSI A190.1.

B. Material Certificates: For preservative-treated wood products, from manufacturer. Indicate type of preservative used and net amount of preservative retained.

C. Research/Evaluation Reports: For [**structural glued-laminated timber**][**and**][**timber connectors**], from ICC-ES.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: [**An AITC- or APA-EWS-licensed firm**][**certified for chain of custody by an FSC-accredited certification body**].

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with provisions in AITC 111.

B. Individually wrap members using plastic-coated paper covering with water-resistant seams.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality

Requirements," to design structural glued-laminated timber and connectors.

B. Structural Performance: Structural glued-laminated timber and connectors are to withstand the effects of structural loads shown on Drawings without exceeding allowable design working stresses listed in ANSI 117 or determined according to ASTM D3737 and acceptable to authorities having jurisdiction.

C. Seismic Performance: Structural glued-laminated timber and connectors are to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 STRUCTURAL GLUED-LAMINATED TIMBER

A. General: Provide structural glued-laminated timber that complies with ANSI A190.1 and ANSI 117 or research/evaluation reports acceptable to authorities having jurisdiction.

1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.
2. Provide structural glued-laminated timber made from single species.
3. Provide structural glued-laminated timber made from solid lumber laminations; do not use laminated veneer lumber.
4. Provide structural glued-laminated timber made with wet-use adhesive complying with ANSI A190.1.
5. Adhesives: Do not use adhesives that contain urea formaldehyde.
6. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Adhesives: Do not use adhesives that contain urea formaldehyde.
9. Adhesives: Do not use adhesives that contain urea formaldehyde.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to

FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

L. Species and Grades for Structural Glued-Laminated Timber:

1. [**Alaska cedar**][**Douglas fir-larch**][**Southern pine**][**Any species**] in grades needed to comply with "Performance Requirements" Article.
2. [**Alaska cedar**][**Douglas fir-larch**][**Southern pine**][**Any species**] that complies with [**structural properties**][**combination symbols**][**beam stress classifications**] indicated.

M. Species and Grades: For [**beams**][**and**][**purlins**].

1. Species and Beam Stress Classification: [**Ponderosa pine, 16F-1.3E**][**Alaska cedar, 20F-1.5E**][**Eastern spruce, 20F-1.5E**][**Any species, 20F-1.5E**][**Any species, 24F-1.7E**][**Douglas fir-larch, 24F-1.8E**][**Southern pine, 24F-1.8E**][**Douglas fir-larch or southern pine, 24F-1.8E**][**Southern pine, 30F-2.1E**].
2. Lay-up: [**Balanced**][**Either balanced or unbalanced**].

N. Species and Grades for Arches:

1. Species and Beam Stress Classification: [**Alaska cedar, 20F-1.5E**][**Eastern spruce, 20F-1.5E**][**Any species, 20F-1.5E**][**Any species, 24F-1.7E**][**Douglas fir-larch, 24F-1.8E**][**Southern pine, 24F-1.8E**][**Douglas fir-larch or southern pine, 24F-1.8E**].
2. Lay-up: [**Balanced**][**Either balanced or unbalanced**].
3. Species and Combination Symbol: [**Alaska cedar, 20F-V13 WS**][**Douglas fir-larch, 24F-V8 WS**][**Southern pine, 24F-V5 SP**][**Alaska cedar, 20F-V12 WS**][**Douglas fir-larch, 24F-V4 WS**][**Southern pine, 24F-V3 SP**].

O. Species and Grades for [**Columns**][**and**][**Truss Members**]:

1. Species and Combination Symbol: [**Alaska cedar, 70**][**Douglas fir-larch, 1**][**Douglas fir-larch, 3**][**Southern pine, 47**][**Southern pine, 50**].

P. Appearance Grade: [**Premium**][**Architectural**][**Industrial**][**Framing**], complying with AITC 110.

1. For Premium and Architectural appearance grades, fill voids as required by AITC 110.[**For Premium appearance grade, use clear wood inserts, of matching grain and color, for filling voids and knot holes more than 1/4 inch (6 mm) wide.**]

2.3 PRESERVATIVE TREATMENT

A. Preservative Treatment: Where preservative-treated structural glued-laminated timber is indicated, comply with AWPA U1, Use [**Category 1**][**Category 2**][**Category 3A**][**Category 3B**][**Category 4A**].

1. Use preservative solution without[**water repellents or**] substances that might interfere with application of indicated finishes.
2. Do not incise structural glued-laminated timber or wood used to produce structural glued-laminated timber.

B. Preservative:[**One of the following:**]

1. Oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
2. Pentachlorophenol in light petroleum solvent.
3. Copper naphthenate in a light petroleum solvent.
4. Ammoniacal zinc copper arsenate (ACZA) in a water solution.
5. Chromated copper arsenate (CCA) in a water solution.
6. Ammoniacal copper quat Type A (ACQ-C) in a water solution.
7. Propiconazole tebuconazole imidacloprid (PTI) in a water emulsion.

C. After dressing members, apply a copper naphthenate field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than **1/16 inch (1.5 mm)**.

2.4 TIMBER CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Simpson Strong-Tie Co., Inc.**]
2. [**USP Structural Connectors**]

B. Fabricate beam seats from [**steel**][**stainless steel**] with [**0.239-inch (6-mm)**][**3/16-inch (5-mm)**][**3/8-inch (9.5-mm)**] bearing plates, **3/4-inch- (19-mm-)** diameter-by-**12-inch- (300-mm-)** long deformed bar anchors, and **0.239-inch (6-mm)** side plates.

C. Fabricate arch base shoes from [**steel**][**stainless steel**] with **1-inch (25-mm)** baseplates and **3/8-inch (9.5-mm)** side plates.

D. Fabricate beam hangers from [**steel**][**stainless steel**] with **0.179-inch (4.6-mm)** stirrups and **0.239-inch (6-mm)** top plates.

E. Fabricate hinge connectors from [**steel**][**stainless steel**] with **0.179-inch (4.6-mm)** side plates and [**3/4-inch (19-mm)**][**1-inch (25-mm)**] top and bottom plates.

F. Fabricate strap ties from [**steel**][**stainless steel**], [**2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm)**][**3 inches (75 mm) wide by 0.239 inch (6 mm)**] thick.

G. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A668/A668M.

H. Provide bolts, **3/4 inch (19 mm)** unless otherwise indicated, complying with **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; nuts complying with **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

I. Provide shear plates, [2-5/8 inches (66.7 mm)][4 inches (102 mm)] in diameter, complying with ASTM D5933.

J. Materials: Unless otherwise indicated, fabricate from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A36/A36M.
2. Round steel bars complying with ASTM A575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A1011/A1011M, Structural Steel, Type SS, Grade 33.
4. Stainless steel flat bars complying with ASTM A666, [**Type 304**][**Type 316**].
5. Stainless steel bars and shapes complying with ASTM A276, [**Type 304**][**Type 316**].
6. Stainless steel plate, sheet, and strip complying with ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].

K. Finish steel assemblies and fasteners with rust-inhibitive primer, **2-mil (0.05-mm)** dry film thickness.

L. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A123/A123M or ASTM A153/A153M.

2.5 MISCELLANEOUS MATERIALS

A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.6 FABRICATION

A. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.

1. Dress exposed surfaces as needed to remove planing and surfacing marks.

B. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.

C. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.

1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

D. End-Cut Sealing: Immediately after end cutting each member to final length[**and after preservative treatment**], apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.

E. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit[**except for preservative-treated wood where treatment included a**

water repellent].

2.7 FACTORY FINISHING

A. Clear Finish: Manufacturer's standard, resistant to mildew and fungus.

1. Water repellent.
2. Film-forming two-coat, [**varnish**][**urethane**].

B. Semitransparent Stain Finish: Manufacturer's standard oil-based stain, resistant to mold and fungus.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

C. Solid-Color Stain Finish: Manufacturer's standard [**oil-based**][**latex**] penetrating stain, resistant to mildew and fungus.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

D. Painted Finish: Acrylic latex system.

1. Prime Coat: Stain blocking primer as recommended by topcoat manufacturer.
2. Intermediate Coat: Matching topcoat.
3. Topcoat: High-performance architectural coating, [**low sheen**][**eggshell**][**satin**][**semigloss**].
4. Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates in areas to receive structural glued-laminated timber, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

1. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.

B. Framing Built into Masonry: Provide **1/2-inch (13-mm)** clearance at tops, sides, and ends of members built into masonry; bevel cut ends **3 inches (76 mm)**; and do not embed more than **4 inches (102 mm)** unless otherwise indicated.

C. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements

for shop fabrication.

D. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing[**and finishing**].

1. Predrill for fasteners using timber connectors as templates.
2. Finish exposed surfaces to remove planing or surfacing marks and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Coat cross cuts with end sealer.
4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

    a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
    b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Install timber connectors as indicated.

1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
2. Install bolts with orientation as indicated or, if not indicated, as directed by the Owner.

3.3 ADJUSTING

A. Repair damaged surfaces[**and finishes**] after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect, as directed by the Owner.

3.4 PROTECTION

A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.

1. Coordinate wrapping removal with finishing work. Retain wrapping where it can serve as a painting shield.
2. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

END OF SECTION 06 18 00 00

Task	Specification	Specification Description
06 18 13 00	06 18 00 00	Glued-Laminated Construction
06 18 16 00	06 10 00 00	Rough Carpentry
06 18 16 00	06 18 00 00	Glued-Laminated Construction

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SECTION 07 05 13 00 - ATACTIC-POLYPROPYLENE (APP) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Atactic-polypropylene (APP)-modified bituminous membrane roofing system.
2. Base sheet.
3. Cap sheet.
4. Base flashing sheet.
5. Accessory roofing system materials.
6. Substrate board.
7. Vapor retarder.
8. Roof insulation and accessories.
9. Cover board.
10. Electronic leak-detection (ELD) materials.
11. Roof coating system.
12. Walkways.

B. Section contains installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, and attachment details to other Work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastener spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.
8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: For the following products, as directed by the Owner:

1. Cap Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
2. Base Flashing Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
3. Roof Coating System: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
4. Walkways: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].

D. Wind-Uplift Resistance Submittal: For roofing system indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, for tests performed by an independent, qualified testing agency indicating compliance with specified requirements.

C. Research Reports: For components of membrane roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified modified bitumen system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified modified bitumen system installers**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in accordance with roofing system manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**25**][**30**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test section in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and installation required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34, [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical to that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance index (SRI) of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 ATACTIC-POLYPROPYLENE (APP)-MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM

A. APP Roofing System Components: See the following articles for individual roof materials required for [**two**][**three**]-ply roofing system; [**cold-applied adhesive**][**heat-welded (torch)**] installation method [**with self-adhered base sheet layer**][**with mechanically fastened base sheet layer**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Performance Roof Systems**]
h. [**Polyglass U.S.A., Inc.**]
i. [**Tremco Incorporated**]

2.4 BASE SHEET

A. APP-Modified Bitumen, Polyester-Mat Base Sheet: ASTM D6222/D6222M, [**Type I**][**Type II**], Grade S, reinforced with polyester fabric; smooth surfaced; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Performance Roof Systems**]
h. [**Polyglass U.S.A., Inc.**]

B. APP-Modified Bitumen, Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6223/D6223M, [**Type I**][**Type II**], Grade S, reinforced with a combination of polyester fabric and glass fibers; smooth surfaced; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

C. APP-Modified Bitumen, Glass-Fiber-Mat Base Sheet: ASTM D6509/D6509M, reinforced with glass fibers; smooth surfaced; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]

c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Mule-Hide Products Co., Inc**]
e. [**Performance Roof Systems**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Tremco Incorporated**]

D. Asphalt-Coated, Glass-Fiber-Mat Base Sheet: ASTM D4601/D4601M, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

E. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II, venting, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on bottom surface.

2.5 CAP SHEET

A. APP-Modified Bitumen, Polyester-Mat, Smooth-Surfaced Cap Sheet: ASTM D6222/D6222M, [**Type I**][**Type II**], Grade S, reinforced with polyester fabric; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Mule-Hide Products Co., Inc**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Tremco Incorporated**]

B. APP-Modified Bitumen, Polyester- and Glass-Fiber-Mat, Smooth-Surfaced Cap Sheet: ASTM D6223/D6223M, [**Type I**][**Type II**], Grade S, reinforced with a combination of polyester fabric and glass fibers; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

C. APP-Modified Bitumen, Polyester-Mat, Granule-Surfaced Cap Sheet: ASTM D6222/D6222M, [**Type I**][**Type II**], Grade G, reinforced with polyester fabric; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Performance Roof Systems**]
h. [**Polyglass U.S.A., Inc.**]
i. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

D. APP-Modified Bitumen, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet: ASTM D6223/D6223M, [**Type I**][**Type II**], Grade G, reinforced with a combination of polyester fabric and glass fibers; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.6 BASE FLASHING SHEET

A. APP-Modified Bitumen, Base Flashing Sheet: Matching cap sheet, suitable for installation method specified.

B. Liquid Base Flashing System: Roofing membrane manufacturer's standard moisture-curing resin with low solvent content, consisting of a primer, flashing cement, and reinforcing scrim; suitable for installation method specified.

2.7 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing system components, and suitable for installation method specified.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.

g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

C. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

D. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft. (0.16 kg/sq. m)**.

E. Metal Termination Bars: Manufacturer's standard, predrilled, stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by3 mm)** thick; with anchors.

F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roofing membrane manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive; specially formulated for compatibility and use with [**roofing membrane sheets**][**base flashing sheets**]; designed for adhering roofing system components to substrate and each other; tested by roofing system manufacturer to meet performance requirements.

G. Cold-Applied Polymer-Modified Asphalt Adhesive: Roofing membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive; specially formulated for compatibility and use with [**roofing membrane sheets**][**base flashing sheets**]; designed for adhering roofing system components to substrate and each other; tested by roofing system manufacturer to meet performance requirements.

H. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

I. Self-Adhered Primer: Roofing membrane manufacturer's standard primer to enhance the adhesion of membrane to substrate.

J. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

K. Roofing Granules: Roofing membrane manufacturer's standard ceramic-coated mineral roofing granules, No. 11 screen size with 100 percent passing **No. 8 (2.36-mm)** sieve and 98 percent of mass retained on **No. 40 (0.425-mm)** sieve; color matching cap sheet.

L. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

M. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.8 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Substrate Board: ASTM C1278/C1278M.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. High-Density Polyisocyanurate Roof Substrate Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.9 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.10 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards, manufactured[**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav-listed roof assemblies**][**SPRI's "Directory of Roof Assemblies" listed roof assemblies**].

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45 lb/cu. ft. (23 kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.00 lb/cu. ft. (48 kg/cu. m) minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DuPont de Nemours, Inc.**]
b. [**Kingspan Insulation LLC**]
c. [**Owens Corning**]
d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. ft. (18 kg/cu. m)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Carlisle Syntec Systems**]
c. [**Cellofoam North America, Inc.**]
d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.

3. Size: [48 by 48 inches (1219 by 1219 mm)][48 by 96 inches (1219 by 2438 mm)].
4. Thickness:

    a. Base Layer: [1-1/2 inches (38 mm)].

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35 lb/cu. ft. (22 kg/cu. m)**][**Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)**][**Type IX, 1.8 lb/cu. ft. (29 kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cellofoam North America, Inc.**]
    b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2 cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [48 by 48 inches (1219 by 1219 mm)][48 by 96 inches (1219 by 2438 mm)].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Polyiso Roof and Wall Insulation**]
    b. [**Carlisle Syntec Systems**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Elevate; Holcim Building Envelope**]
    e. [**GAF**]
    f. [**Hunter Panels; a Carlisle company**]
    g. [**IKO Industries Inc.**]
    h. [**Insulfoam; a Carlisle Company**]
    i. [**Johns Manville; a Berkshire Hathaway company**]
    j. [**Kingspan Insulation LLC**]
    k. [**Polyglass U.S.A., Inc.**]
    l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [48 by 48 inches (1219 by 1219 mm)][48 by 96 inches (1219 by 2438 mm)].
4. Thickness:

    a. Base Layer: [1-1/2 inches (38 mm)].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [Atlas Polyiso Roof and Wall Insulation]
b. [CertainTeed; SAINT-GOBAIN]
c. [Elevate; Holcim Building Envelope]
d. [GAF]
e. [Hunter Panels; a Carlisle company]
f. [Insulfoam; a Carlisle Company]
g. [Johns Manville; a Berkshire Hathaway company]

2. Facer: [Type IV cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick][Type V oriented strand board facer, 7/16 inch (11 mm) thick][Type VII glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick].
3. Size: [48 by 48 inches (1219 by 1219 mm)][48 by 96 inches (1219 by 2438 mm)].

G. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [Blue Ridge Fiberboard]
b. [GAF]
c. [Georgia-Pacific Gypsum LLC]
d. [Homasote Company]
e. [Huebert Fiberboard Inc]

2. Thermal Resistance: R-value of 2.78 per 1 inch (25 mm).
3. Size: [48 by 48 inches (1219 by 1219 mm)][48 by 96 inches (1219 by 2438 mm)].
4. Thickness:

a. Base Layer: [1 inch (25 mm)][2 inches (51 mm)].

H. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with 11.2 lb/cu. Ft. (180 kg/cu. M) density and a lower layer with 7.5 lb/cu. Ft. (120 kg/cu. M) density.

1. Thermal Resistance: R-value of 3.8 per 1 inch (25 mm).
2. Size: 48 by 48 inches (1219 by 1219 mm).
3. Thickness:

a. Base Layer: [2 inches (51 mm)]

I. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material with 12.5 lb/cu. Ft. (200 kg/cu. M) density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1219 by 1219 mm)**.
3. Thickness: **1 inch (25 mm)**.

J. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

    a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
    b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

K. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use, compatibility with other roofing system components, and suitable for installation method specified.

L. Insulation Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

M. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
4. Verify adhesives and sealants comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

N. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing**

cellulosic-fiber insulation board].

O. Wood Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."

P. Tapered Edge Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

2.11 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use; compatible with other roofing system components and suitable for installation method specified.

B. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Panel Cover Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass**][**Paper**] facer.

H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

I. Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 1, **1/2 inch (13 mm)** thick.

2.12 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.13 ROOF COATING SYSTEM

A. Primer: Roof coating manufacturer's standard primer to enhance the adhesion of roof coating to substrate.

B. Asphalt Emulsion Coating, Asbestos Free: ASTM D1227/D1227M, Type II, [**Class 1, mineral-colloid-emulsified, fibered**][**Class 2, chemically emulsified, filled or fibered**].

C. Asphalt Emulsion Coating, Nonfibered: ASTM D1227/D1227M, Type III, [**Class 1, mineral-colloid-emulsified**][**Class 2, chemically emulsified**].

D. Aluminum-Pigmented Asphaltic Coating: ASTM D2824/D2824M, [**Type I, nonfibered**][**Type III, fibered, asbestos-free**].

E. Acrylic Elastomer Emulsion Coating: ASTM D6083/D6083M, formulated for use on bituminous roof surfaces.

F. Silicone Coating: ASTM D6694/D6694M, formulated for use on bituminous roof surfaces.

G. Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.14 WALKWAYS

A. Walkway Pads: [**Reinforced asphaltic composition pads with slip-resisting mineral-granule surface**][**Polymer-modified, reconstituted rubber pads with slip-resisting textured surface**], manufactured as a traffic pad for foot traffic and acceptable to roofing membrane manufacturer.

1. Pad Size: Approximately [36 by 60 inches (914 mm by 1524 mm)][30 by 30 inches (762 mm by 762mm)].
2. Color: [**Contrasting with cap sheet**][**Gray**][**Yellow**][**White**].

B. Walkway Cap Sheet Strips: Matching cap sheet; suitable for installation method specified, and as follows:

1. Size: [36 by 60 inches (914 mm by 1524 mm)].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.

    a. Test Frequency: One test probe per each [1000 sq. ft. (93 sq. m)], or portion thereof, of roof deck, with not less than three test probes.
    b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within 1/8 inch (3 mm) at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written installation instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include roofing system manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind-uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof deck in accordance with roof deck manufacturer's written installation instructions.

3.3 INSTALLATION OF ATACTIC-POLYPROPYLENE (APP)-MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings. Provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie into existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified in [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Substrate-Joint Penetrations: Prevent adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting

sloping roof decks.

4. Fasten substrate board to top flanges of steel roof deck in accordance with roofing system manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written installation instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
2. Continuously seal side and end laps.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

D. Nailer Strips: Mechanically fasten **4-inch nominal- (89-mm actual-)** width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:

1. [16 ft. (4.88 m)] apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
2. [48 inches (1219 mm)] apart for roof slopes greater than 3 inches per 12 inches (3:12).

E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing system with vertical surfaces or angle changes greater than 45 degrees.

3.7 INSTALLATION OF COVER BOARD

A. Comply with roofing system and insulation manufacturer's written installation instructions.

B. Install cover board over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
3. Trim cover board so that water flow is unrestricted.
4. Cut and fit cover board tight to nailers, projections, and penetrations.
5. Secure cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
6. Secure cover board to resist specified uplift pressure at corners, perimeter, and field of roof.

C. Install sheathing paper over cover board and immediately beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF APP ROOFING MEMBRANE, GENERAL

A. Install roofing membrane in accordance with roofing system manufacturer's written installation instructions and applicable recommendations in NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Where roof slope exceeds [1/2 inch per 12 inches (1:24)][3/4 inch per 12 inches (1:18)], install roofing membrane sheets parallel with slope.

1. Backnail roofing sheets to [**nailer strips**][**substrate**] in accordance with roofing system manufacturer's written installation instructions.

D. Coordinate installation of roofing system so insulation and other components of roofing system not

permanently exposed are not subjected to precipitation or left uncovered at end of workday or when rain is forecast.

1. Provide tie-offs at end of day's work to cover exposed roofing sheets and insulation with a course of roofing membrane set in adhesive, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.10 INSTALLATION OF BASE SHEET

A. Prime surface of substrate with primer in accordance with roofing membrane manufacturer's written installation instructions and allow primer to dry.

B. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for time recommended by roofing membrane manufacturer for the ambient temperature at which base sheet will be installed.

C. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

D. Installation of Base Sheet:

1. Install base sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.
2. Extend base sheet over and terminate above cants.
3. Install base sheet in a shingle fashion.
4. Adhere base sheet to substrate in a uniform coating of cold-applied adhesive.
5. Heat-weld (torch-apply) base sheet to substrate.
    a. Perform torch application in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.
6. Self-adhere base sheet to substrate.
7. Mechanically fasten base sheet to substrate using fasteners specifically designed and sized for [**wood**][**wood panel**] decks.
    a. Fasten base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
8. Install base sheet without wrinkles, rears, and free from air pockets.
9. Laps: Accurately align base sheet, without stretching, and maintain uniform side and end laps.
    a. Lap side laps as recommended by roofing membrane manufacturer, but not less than **3 inches (75 mm)**.
    b. Lap end laps as recommended by roofing membrane manufacturer, but not less than **12 inches (300 mm)**. Stagger end laps not less than **18 inches (450 mm)**.
    c. [**Heat-weld end**][**Completely bond and seal**] laps, leaving no voids.
    d. Roll laps with a **20 lb (9 kg)** roller.
10. Repair tears and voids in laps and lapped seams not completely sealed.
11. Apply pressure to body of base sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

E. Installation of Venting Base Sheet:

1. [**Mechanically fasten sheet to substrate, using fasteners specifically designed and sized for substrate**][**Spot or strip mop sheet to substrate with cold-applied adhesive**] with venting side down.

   a. Secure venting base sheet to substrate in accordance with requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies for specified wind-uplift load capacity**].
   b. Secure venting base sheet to resist uplift pressure at corners, perimeter, and field of roof.

3.11 INSTALLATION OF CAP SHEET

A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for time recommended by roofing membrane manufacturer for the ambient temperature at which cap sheet will be installed.

B. Install cap sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.

1. Extend cap sheet over and terminate above cants.
2. Install cap sheet in a shingle fashion.
3. Adhere cap sheet to bottom layer in a uniform coating of cold-applied adhesive.
4. Heat-weld (torch-apply) cap sheet to bottom layer.

   a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

5. Install cap sheet without wrinkles or tears, and free from air pockets.
6. Install cap sheet so side and end laps shed water.

C. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps.

1. Lap side laps as recommended by roofing membrane manufacturer, but not less than **3 inches (75 mm)**.
2. Lap end laps as recommended by roofing membrane manufacturer, but not less than **12 inches (300 mm)**.
3. Stagger end laps not less than **18 inches (450 mm)**.
4. [**Heat-weld end**][**Completely bond and seal**] laps, leaving no voids.
5. Roll laps with a **20 lb (9 kg)** roller.
6. Repair tears and voids in laps and lapped seams not completely sealed.

D. Apply pressure to body of cap sheet in accordance with roofing membrane written manufacturer's instructions, to remove air pockets and to result in complete adhesion of cap sheet to substrate.

E. Apply roofing granules of same color as cap sheet to cover exuded bead at laps while bead is hot, to provide a continuous color appearance.

3.12 INSTALLATION OF BASE FLASHING AND STRIPPING

A. Install base flashing sheet over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates in accordance with roofing system manufacturer's

written installation instructions and as follows:

1. Prime substrates with primer if required by roofing system manufacturer.
2. Base Flashing Sheet Application, Cold: Adhere base flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
3. Base Flashing Sheet Application, Hot: Head-weld (torch-apply) base flashing sheet to substrate.

    a. Perform torch application in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

B. Extend base flashing sheet up walls or parapets a minimum of **8 inches (200 mm)** above roofing membrane and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing sheet securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing sheet.

D. Install liquid flashing system in accordance with roofing system manufacturer's written installation instructions.

1. Extend liquid flashing not less than **3 inches (75 mm)** in all directions from edges of item being flashed.
2. Embed granules, matching color of cap sheet, into wet compound.

E. Install cap sheet stripping where metal flanges and edgings are set on roof in accordance with roofing system manufacturer's written installation instructions.

F. Roof Drains: Set [**30-by-30-inch (760-by-760-mm)**], **4 lb (1.8 kg)** flashing in bed of adhesive on completed roofing membrane.

1. Cover flashing with cap sheet stripping, and extend a minimum of [**4 inches (100 mm)**][**6 inches (150 mm)**] beyond edge of metal flashing onto field of roofing membrane.
2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping in accordance with roofing system manufacturer's written installation instructions.

3.13 INSTALLATION OF ROOF COATING SYSTEM

A. Apply coating to [**smooth-surfaced cap sheet**][**base flashing sheet**] in accordance with roofing membrane manufacturer's written application instructions, by spray, roller, or other suitable application method[**, to provide a dry film thickness of not less than 20 mils (0.5 mm)**].

3.14 INSTALLATION OF WALKWAYS

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size, secure to cap sheet in accordance with roofing system manufacturer's written installation instructions.

1. Install walkways at the following locations:

    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit

locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing system manufacturer's warranty requirements.

2. Provide **3-inch (75-mm)** clearance between adjoining pads.

B. Walkway Cap Sheet Strips: Install walkway cap sheet strips over roofing membrane, using same installation method as that used for cap sheet.

1. Install walkways strips at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining strips.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections of substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957 after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)**

of clearance from top of base flashing.

b. Flood each area for [**24**][**48**][**72**] hours.

c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or by nuclear hydrogen detection testing.

b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

1. Determine approximate quantities of components within roofing membrane in accordance with ASTM D3617/D3617M.
2. Examine test specimens for voids between plies in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in NRCA's "Quality Control Guidelines for the

Application of Polymer Modified Bitumen Roofing."

3. Repair areas where test cuts were made in accordance with roofing system manufacturer's written installation instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect[**and the Owner**] 48 hours in advance of date and time of inspection.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

G. Prepare test and inspection reports.

3.16 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.17 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following project:

1. the Owner.:
2. the Owner.Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

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SECTION 07 05 13 00A - STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing system.
2. Base sheet.
3. Cap sheet.
4. Base flashing sheet.
5. Asphalt materials.
6. Accessory roofing system materials.
7. Substrate board.
8. Vapor retarder.
9. Roof insulation and accessories.
10. Cover board.
11. Electronic leak-detection (ELD) materials.
12. Walkways.

B. Section contains installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project**

site].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, and attachment details to other Work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation layout, including slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastener spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.

8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: Actual sample of finished products for the following products, as directed by the Owner:

1. Cap Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
2. Base Flashing Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
3. Walkways: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of complying with performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified modified bitumen system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified modified bitumen system installers**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in accordance with roofing system manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**25**][**30**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by Roofing System Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test section in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and installation required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical to that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial Solar Reflectance Index (SRI) of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM

A. Roofing System Components: See the following articles for individual roof materials required for [**two**][**three**] ply roofing system; [**hot-applied asphalt**][**cold-applied adhesive**][**heat-welded (torch)**][**self-adhered**][**mechanically fastened**] installation method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Garland Company, Inc. (The)**]
f. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
g. [**Johns Manville; a Berkshire Hathaway company**]
h. [**Malarkey Roofing Products**]
i. [**MBTechnology**]
j. [**Mule-Hide Products Co., Inc**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Siplast**]
m. [**Soprema, Inc.**]
n. [**Tamko Building Products LLC**]
o. [**Tremco Incorporated**]

2.4 BASE SHEET

A. SBS-Modified Bitumen Polyester-Mat Base Sheet: ASTM D6164/D6164M, [**Type I**][**Type II**], Grade S, reinforced with polyester fabric, smooth surfaced, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Siplast**]
h. [**Soprema, Inc.**]
i. [**Tremco Incorporated**]

B. SBS-Modified Bitumen Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, [**Type I**][**Type II**][**Type III**], Grade S, reinforced with glass fibers, smooth surfaced, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Garland Company, Inc. (The)**]
f. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings &

Waterproofing Inc. brands)]
g. [**Johns Manville; a Berkshire Hathaway company**]
h. [**Malarkey Roofing Products**]
i. [**Mule-Hide Products Co., Inc**]
j. [**Polyglass U.S.A., Inc.**]
k. [**Siplast**]
l. [**Soprema, Inc.**]
m. [**Tamko Building Products LLC**]
n. [**Tremco Incorporated**]

C. SBS-Modified Bitumen Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6162/D6162M, [**Type I**][**Type II**][**Type III**], Grade S, reinforced with a combination of polyester fabric and glass fibers, smooth surfaced, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**Garland Company, Inc. (The)**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**MBTechnology**]
e. [**Polyglass U.S.A., Inc.**]
f. [**Soprema, Inc.**]
g. [**Tremco Incorporated**]

2.5 CAP SHEET

A. SBS-Modified Bitumen, Granule-Surfaced, Polyester-Mat Cap Sheet: ASTM D6164/D6164M, [**Type I**][**Type II**], Grade G, reinforced with polyester fabric, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Polyglass U.S.A., Inc.**]
h. [**Siplast**]
i. [**Soprema, Inc.**]
j. [**Tamko Building Products LLC**]
k. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

B. SBS-Modified Bitumen, Granule-Surfaced, Glass-Fiber-Mat Cap Sheet: ASTM D6163/D6163M, [**Type I**][**Type II**][**Type III**], Grade G, SBS-modified asphalt sheet, reinforced with glass fibers, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Garland Company, Inc. (The)**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Malarkey Roofing Products**]
h. [**MBTechnology**]
i. [**Polyglass U.S.A., Inc.**]
j. [**Siplast**]
k. [**Soprema, Inc.**]
l. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

C. SBS-Modified Bitumen, Granule-Surfaced, Polyester and Glass-Fiber-Mat Cap Sheet: ASTM D6162/D6162M, [**Type I**][**Type III**], Grade G, reinforced with a combination of polyester fabric and glass fibers, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Garland Company, Inc. (The)**]
d. [**Johns Manville; a Berkshire Hathaway company**]
e. [**Soprema, Inc.**]
f. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.6 BASE FLASHING SHEET

A. SBS-Modified Bitumen, Smooth-Surfaced Backer Sheet: Matching base sheet, suitable for installation method specified.

B. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], asphalt-impregnated and coated glass-fiber sheet, dusted with fine mineral surfacing on both sides, suitable for installation method specified.

C. SBS-Modified Bitumen, Granule-Surfaced Base Flashing Sheet: Matching cap sheet, suitable for installation method specified.

D. SBS-Modified Bitumen, Metal-Surfaced Base Flashing Sheet: ASTM D6298/D6298M, metal-foil-surfaced sheet, reinforced with glass fibers, suitable for installation method specified, and as follows:

1. Metal Surfacing: [**Aluminum**][**Copper**][**Stainless steel**][**Aluminum, fluoropolymer-coated finish, of color and gloss selected by Architect from manufacturer's full range**].

E. Liquid Base Flashing System: Roofing membrane manufacturer's standard moisture curing resin with low solvent content, consisting of a primer, flashing cement, and reinforcing scrim, suitable for installation method specified.

2.7 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D41/D41M.

B. Roofing Asphalt: ASTM D312/D312M, [**Type III**][**Type IV**][**Type III or IV as recommended by roofing system manufacturer**], suitable for installation method specified.

C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M, suitable for installation method specified.

2.8 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing system components, and suitable for installation method specified.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

C. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

D. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft. (0.16 kg/sq. m)**.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars,

approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roofing membrane manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with [**roofing membrane sheets**][**base flashing sheets**]; designed for adhering roofing system components to substrate and each other, tested by roofing system manufacturer to meet performance requirements.

G. Cold-Applied Polymer-Modified Asphalt Adhesive: Roofing membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with [**roofing membrane sheets**][**base flashing sheets**]; designed for adhering roofing system components to substrate and each other, tested by roofing system manufacturer to meet performance requirements.

H. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing membrane manufacturer.

I. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

J. Self-Adhered Primer: Roofing membrane manufacturer's standard primer to enhance the adhesion of membrane to substrate.

K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

L. Roofing Granules: Roofing membrane manufacturer's standard ceramic-coated mineral roofing granules, No. 11 screen size with 100 percent passing **No. 8 (2.36-mm)** sieve and 98 percent of mass retained on **No. 40 (0.425-mm)** sieve; color matching cap sheet.

M. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

N. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.9 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M.

1. Thickness: [1/4 inch (6 mm)][3/8 inch (10 mm)][1/2 inch (13 mm)][5/8 inch (16 mm)].

C. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, 1/2 inch (13 mm) thick, having a minimum compressive strength of 80 psi (551 kPa).

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.10 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil (1.0-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil (0.76-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than 0.062 perm (3.556 ng/Pa x s x sq. m) when tested in accordance with ASTM E96/E96M.
3. Flame Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.11 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards, manufactured[**approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45 lb/cu. Ft. (23 kg/cu. M) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.00 lb/cu. Ft. (48 kg/cu. M) minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**DuPont**]
b. [**Kingspan Insulation LLC**]
c. [**Owens Corning**]
d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. Ft. (18 kg/cu. M)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Carlisle Syntec Systems**]
c. [**Cellofoam North America, Inc.**]
d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35 lb/cu. Ft. (22 kg/cu. M)**][**Type VIII, 1.15 lb/cu. Ft. (18 kg/cu. M)**][**Type IX, 1.8 lb/cu. Ft. (29 kg/cu. M)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**Cellofoam North America, Inc.**]
b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick][DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer][Class 2 coated glass-**

fiber facer][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Polyiso Roof and Wall Insulation**]
    b. [**Carlisle Syntec Systems**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Elevate; Holcim Building Envelope**]
    e. [**GAF**]
    f. [**Hunter Panels; a Carlisle company**]
    g. [**IKO Industries Inc.**]
    h. [**Insulfoam; a Carlisle Company**]
    i. [**Johns Manville; a Berkshire Hathaway company**]
    j. [**Kingspan Insulation LLC**]
    k. [**Polyglass U.S.A., Inc.**]
    l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

    a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber-mat facer on the other surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Polyiso Roof and Wall Insulation**]
    b. [**Carlisle Syntec Systems**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Elevate; Holcim Building Envelope**]
    e. [**GAF**]
    f. [**Hunter Panels; a Carlisle company**]
    g. [**IKO Industries Inc.**]
    h. [**Insulfoam; a Carlisle Company**]
    i. [**Johns Manville; a Berkshire Hathaway company**]
    j. [**Kingspan Insulation LLC**]
    k. [**Polyglass U.S.A., Inc.**]
    l. [**Rmax, A Business Unit of Sika Corporation**]

2. Facer: [**Type IV cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GAF**]
   b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Ridge Fiberboard**]
   b. [**GAF**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Homasote Company**]
   e. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1 inch (25 mm)**][**2 inches (50 mm)**].

I. Cellular-Glass Board Insulation: ASTM C552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Pittsburgh Corning Corporation**]

2. Thermal Resistance: R-value of 3.44 per **1 inch (25 mm)**.
3. Size: **24 by 48 inches (600 by 1200 mm)**.

J. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with a **11.2 lb/cu. Ft. (180 kg/cu. M)** density and a lower layer with a **7.5 lb/cu. Ft. (120 kg/cu. M)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness:

    a. Base Layer: [**2 inches (50 mm)**].

4. Face Treatment: Bitumen coating.

K. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having a **12.5 lb/cu. Ft. (200 kg/cu. M)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.
4. Face Treatment: Bitumen coating.

L. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

    a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
    b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

M. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use, compatible with other roofing system components and suitable for installation method specified.

N. Insulation Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing membrane manufacturer.

O. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
4. Verify adhesives and sealants comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.

i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

P. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

Q. Wood Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."

R. Tapered Edge Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

2.12 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use; compatible with other roofing system components and suitable for installation method specified.

B. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with nonasphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Panel Cover Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**]

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

I. Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 1, **1/2 inch (13 mm)** thick.

2.13 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.14 WALKWAYS

A. Walkway Pads: [**Reinforced asphaltic composition pads with slip-resisting mineral-granule surface**][**Polymer-modified, reconstituted rubber pads with slip-resisting textured surface**], manufactured as a traffic pad for foot traffic and acceptable to roofing membrane manufacturer.

1. Pad Size: Approximately [**36 by 60 inches (914 mm by 1524 mm)**][**30 by 30 inches**

(762 mm by 762mm)].
2. Color: [**Contrasting with cap sheet**][**Gray**][**Yellow**][**White**].

B. Walkway Cap Sheet Strips: Matching cap sheet; suitable for installation method specified, and as follows:

1. Size: [**36 by 60 inches (914 mm by 1524 mm)**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.

    a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
    b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written installation instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete roof deck with asphalt primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include roofing system manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind-uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof decks in accordance with roof deck manufacturer's written installation instructions.

3.3 INSTALLATION OF STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav listed roof**][**SPRI's "Directory of Roof Assemblies" listed roof**] assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings. Provide temporary seals to prevent water from entering completed sections of roofing system at the end of workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified in [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Asphalt Heating: Heat and apply hot asphalt in accordance with roofing system manufacturer's written installation instructions.

1. Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before installation.
2. Circulate asphalt during heating.
3. Do not raise asphalt temperature above equiviscous temperature range more than one hour before time of installation.
4. Do not exceed asphalt manufacturer's recommended temperature limits during asphalt heating.
5. Do not heat asphalt within **25 deg F (14 deg C)** of flash point.
6. Discard asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
7. Apply hot asphalt within **plus or minus 25 deg F (plus or minus 14 deg C)** of equiviscous

temperature.

F. SEBS-Modified Asphalt Heating: Heat and apply hot asphalt in accordance with roofing system manufacturer's written installation instructions.

G. Substrate-Joint Penetrations: Prevent hot-applied asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel roof deck in accordance with roofing system manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel roof deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written installation instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
2. Continuously seal side and end laps.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less

than 12 inches (300 mm) from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus 24 inches (600 mm).
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
6. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

D. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:

1. [16 ft. (4.88 m)] apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
2. [48 inches (1200 mm)] apart for roof slopes greater than 3 inches per 12 inches (3:12).

E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing system with vertical surfaces or angle changes greater than 45 degrees.

3.7 INSTALLATION OF COVER BOARD

A. Comply with roofing system and insulation manufacturer's written installation instructions.

B. Install cover board over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
3. Trim cover board, so that water flow is unrestricted.
4. Cut and fit cover board tight to nailers, projections, and penetrations.
5. Secure cover board to insulation in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
6. Secure cover board to resist specified uplift pressure at corners, perimeter, and field of roof.

C. Install sheathing paper over cover board and immediately beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored

moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF SBS ROOFING MEMBRANE, GENERAL

A. Install roofing membrane in accordance with roofing system manufacturer's written installation instructions and applicable recommendations in NRCA's "Quality-Control Guidelines for the Application of Polymer-Modified Bitumen Roofing."

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Where roof slope exceeds [**1/2 inch per 12 inches (1:24)**][**3/4 inch per 12 inches (1:18)**], install roofing membrane sheets parallel with slope.

1. Backnail roofing sheets to [**nailer strips**][**substrate**] in accordance with roofing system manufacturer's written installation instructions.

D. Coordinate installation of roofing system so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at end of workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing sheets and insulation with a course of coated felt set in adhesive, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.10 INSTALLATION OF BASE SHEET

A. Prime surface of substrate with primer in accordance with roofing membrane manufacturer's written installation instructions and allow primer to dry.

B. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for a time period recommended by roofing membrane manufacturer for the ambient temperature at which base sheet will be installed.

C. Loosely lay one course of sheathing paper, lapping edges, and ends a minimum of **2 inches (50 mm)** and **6 inches (150 mm)**, respectively.

D. Installation of Base Sheet:

1. Install base sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.
2. Extend base sheet over and terminate above cants.
3. Install base sheet in a shingle fashion.
4. Adhere base sheet to substrate in a uniform coating of [**hot-applied asphalt**][**cold-applied adhesive**].
5. Self-adhere base sheet to substrate.
6. Heat-weld (torch-apply) base sheet to substrate.

a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

7. Mechanically fasten base sheet to substrate using fasteners specifically designed and sized for [**wood**][**wood panel**] decks.

    a. Fasten base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

8. Install base sheet without wrinkles or rears, and free from air pockets.
9. Laps: Accurately align base sheet, without stretching, and maintain uniform side and end laps.

    a. Lap side laps as recommended by roofing membrane manufacturer but not less than **3 inches (75 mm)**.
    b. Lap end laps as recommended by roofing membrane manufacturer but not less than **12 inches (300 mm)**. Stagger end laps not less than **18 inches (450 mm)**.
    c. [**Heat-weld end laps,**][**Completely bond and seal laps,**] leaving no voids.
    d. Roll laps with a **20 lb (9 kg)** roller.

10. Repair tears and voids in laps and lapped seams not completely sealed.
11. Apply pressure to body of base sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

E. Installation of Vented Base Sheet:

1. [**Mechanically fasten, using fasteners specifically designed and sized for applicable substrate**][**Spot or strip mop to substrate with hot-applied asphalt**] vented base sheet with vented side down.

    a. Fasten vented base sheet in accordance with [**FM Approval's RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
    b. Fasten vented base sheet to resist uplift pressure at corners, perimeter, and field of roof.

3.11 INSTALLATION OF CAP SHEET

A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for a time period recommended by roofing membrane manufacturer for the ambient temperature at which cap sheet will be installed.

B. Install cap sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.

1. Extend cap sheet over and terminate above cants.
2. Install cap sheet in a shingle fashion.
3. Adhere cap sheet to bottom layer in a uniform coating of [**hot-applied asphalt**][**cold-applied adhesive**].
4. Self-adhere cap sheet to bottom layer.
5. Heat-weld (torch-apply) cap sheet to bottom layer.

    a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

6. Mechanically fasten cap sheet to bottom layer using fasteners specifically designed and sized for [**wood**][**wood panel**] decks.

a. Fasten cap sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

7. Install cap sheet without wrinkles or tears, and free from air pockets.
8. Install cap sheet so side and end laps shed water.

C. Laps: Accurately align roof sheets, without stretching, and maintain uniform side and end laps.

1. Lap side laps as recommended by roofing membrane manufacturer but not less than **3 inches (75 mm)**.
2. Lap end laps as recommended by roofing membrane manufacturer but not less than **12 inches (300 mm)**. Stagger end laps not less than **18 inches (450 mm)**.
3. [**Heat-weld laps**][**Completely bond and seal laps**], leaving no voids.
4. Roll laps with a **20 lb (9 kg)** roller.
5. Repair tears and voids in laps and lapped seams not completely sealed.

D. Apply pressure to body of cap sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and result in complete adhesion of cap sheet to substrate.

E. Apply roofing granules of same color as cap sheet to cover exuded bead at laps while bead is hot, to provide a continuous color appearance.

3.12 INSTALLATION OF BASE FLASHING AND STRIPPING

A. Install base flashing sheet over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates in accordance with roofing system manufacturer's written installation instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Installation: [**Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants**][**Adhere backer sheet to substrate in a uniform layer of**][**hot-applied asphalt**][**cold-applied adhesive**].
3. Base Flashing Sheet Installation, Hot: [**Adhere base flashing sheet to substrate in a solid mopping of hot-applied asphalt applied at asphalt temperature recommended by base flashing sheet manufacturer. Apply hot-applied asphalt to back of base flashing sheet if recommended by roofing system manufacturer**][**Torch-apply base flashing sheet to substrate**].

    a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

4. Base Flashing Sheet Installation, Cold: Adhere base flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.

B. Extend base flashing sheet up walls or parapets a minimum of **8 inches (200 mm)** above roofing membrane and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing sheet securely at terminations and perimeter of roof.

1. Seal top termination of base flashing sheet.

D. Install liquid flashing system in accordance with roofing system manufacturer's written installation instructions.

1. Extend liquid flashing not less than 3 inches (75 mm) in all directions from edges of item being flashed.
2. Embed granules, matching color of cap sheet, into wet compound.

E. Install cap sheet stripping where metal flanges and edgings are set on roof in accordance with roofing system manufacturer's written installation instructions.

F. Roof Drains: Set [30-by-30-inch- (762-by-762-mm-)] 4 lb (1.8 kg) flashing in bed of adhesive on completed roofing membrane.

1. Cover flashing with cap sheet stripping, and extend a minimum of [4 inches (100 mm)][6 inches (150 mm)] beyond edge of metal flashing onto field of roofing membrane.
2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping in accordance with roofing system manufacturer's written installation instructions.

3.13 INSTALLATION OF WALKWAYS

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size; secure to cap sheet in accordance with roofing system manufacturer's written installation instructions.

1. Install walkways at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing system manufacturer's warranty requirements.

2. Provide 3-inch (75-mm) clearance between adjoining pads.

B. Walkway Cap Sheet Strips: Install walkway cap sheet strips over roofing membrane, using same installation method as that used for cap sheet.

1. Install walkways strips at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide 3-inch (76-mm) clearance between adjoining strips.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections of substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roofing membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Flood to an average depth of [2-1/2 inches (63 mm)] with a minimum depth of [1 inch (25 mm)] and not exceeding a depth of [4 inches (100 mm)]. Maintain 2 inches (50 mm) of clearance from top of base flashing.
b. Flood each area for [**24**][**48**][**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing, or by nuclear hydrogen detection testing.
b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roofing system in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roofing system in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

1. Determine approximate quantities of components within roofing membrane in accordance with ASTM D3617/D3617M.
2. Examine test specimens for voids between plys in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 of NRCA's "Quality-Control Guidelines for the Application of Polymer-Modified Bitumen Roofing."
3. Repair areas where test cuts were made in accordance with roofing system manufacturer's written installation instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect and the Owner 48 hours in advance of date and time of inspection.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

G. Prepare test and inspection reports.

3.15 PROTECTION AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.16 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations,

attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect Work to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 05 13 00A

SECTION 07 05 13 00B - CHLOROSULFONATE-POLYETHYLENE (CSPE) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chlorosulfonate-polyethylene (CSPE) roofing.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Asphalt materials.
8. Electronic leak detection (ELD) materials.
9. Ballast.
10. Walkways.

B. Section includes the installation of sound absorbing insulation strips in ribs of roof deck. Sound absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking[**and for wood-based, structural-use roof deck panels**].
2. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
3. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured copings**][**roof edge flashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
8. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written

instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Chlorosulfonate-polyethylene (CSPE) roofing.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Asphalt materials.
8. Electronic leak detection (ELD) materials.
9. Ballast.
10. Walkways.

B. Product Data Submittals:

1. For insulation and roof system component fasteners, include copy of [**FM Approvals' RoofNav**][**SPRI's Directory of Roof Assemblies**] listing.

C. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
    b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
    c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with air barrier.

E. Samples for Verification: For the following products:

1. Roof membrane and flashing, of color required.
2. Aggregate surfacing material in gradation[**and color**] required.
3. Roof paver[**full sized,**] in each color and texture required.
4. Walkway pads or rolls, of color required.

F. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

    a. Submit evidence of complying with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Evaluation Reports: For components of roofing system, from ICC-ES.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality-control reports.

F. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's Directory of Roof Assemblies**] for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roof membrane, base flashings, [**roof insulation,**][**fasteners,**][**cover boards,**][**vapor retarder,**][**substrate board,**][**roof pavers,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**30**] years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, [**roof insulation,**][**fasteners,**][**cover boards,**][**substrate boards,**][**vapor retarders,**][**roof pavers,**] and [**walkway products,**]for the following warranty period:

1. Warranty Period: [**Two**] years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roofing system to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing system to resist impact damage when tested in accordance with ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.

1. Wind Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

I. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**15**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

J. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

K. Energy Star Listing: Roofing system to be listed on the DOE's Energy Star "Roof Products Qualified Product List" for [**low**][**steep**]-slope roof products.

L. Energy Performance: Roofing system to have an initial solar reflectance of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with ANSI/CRRC S100.

M. Exterior Fire-Test Exposure: ASTM E108 or UL 790, [**Class A**][**Class B**][**Class C**]; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

N. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 CHLOROSULFONATE-POLYETHYLENE (CSPE) ROOFING

A. CSPE Sheet: ASTM D5019, Type 1, Grade 2, **45-mil-** **(1.1-mm-)** thick, reinforced, flexible uncured sheet formed from CSPE, and as follows:

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Conklin Company Inc**]
2. [**Tremco Incorporated**]

C. Exposed Face Color: [**White**][**Blue**][**Light gray**][**Tan**].

D. Source Limitations: Obtain components for roofing system from [**manufacturer of roof membrane**][**manufacturer approved by roof membrane manufacturer**].

2.3 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants shall comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.

e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Sheet Flashing: **45-mil- (1.1-mm-)** thick, reinforced or **55-mil- (1.4-mm-)** thick, nonreinforced CSPE, as recommended by roofing system manufacturer for intended use, of same color as CSPE roof membrane.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Roof Vents: As recommended by roof membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

E. Bonding Adhesive: Manufacturer's standard[**water based**].

F. Slip Sheet: [**ASTM D2178/D2178M, Type IV, glass fiber, asphalt-impregnated felt**][**Manufacturer's standard, of thickness required for application**].

G. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt-impregnated fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.

H. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

I. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately **1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick)**, prepunched.

J. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

1. Fasteners: **1-1/2-inch (38-mm)** stainless steel fasteners with neoprene washers.

K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

L. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD

A. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: **5/8 inch (16 mm)**.

B. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

C. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

D. Perlite Board: ASTM C728, seal coated.

1. Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**].

E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 VAPOR RETARDER

A. Polyethylene Film: ASTM D4397, [**6 mils (0.15 mm)**][**10 mils (0.25 mm)**] thick, minimum, with maximum permeance rating of [**0.13 perm (0.084 metric perm)**][**0.076 perm (0.050 metric perm)**].

1. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.
2. Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor retarder application.

B. Laminated Sheet Vapor Retarder: Two-layer, fire-retardant polyethylene laminate, reinforced with cord

grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

C. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

D. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

E. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt impregnated.

2.6 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured[**or approved**] by CSPE roof membrane manufacturer[**approved for use in FM Approvals' RoofNav listed roof assemblies**][**approved for use in SPRI's Directory of Roof Assemblies listed roof assemblies**].

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45-lb/cu. ft. (23-kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.00-lb/cu. ft. (48-kg/cu. m), minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DiversiFoam Products**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**The Dow Chemical Company**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25.4 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15-lb/cu. ft. (18-kg/cu. m)** minimum density, **13-psi (90-kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Carlisle Syntec Systems**]
   c. [**DiversiFoam Products**]
   d. [**Dyplast Products**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25.4 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35-lb/cu. ft. (22-kg/cu. m)**][**Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m)**][**Type IX, 1.8-lb/cu. ft. (29-kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cellofoam North America, Inc.**]
   b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, [**Type II, Class 1, Grade 2**][**Type II, Class 2, Grade 2**], felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Dyplast Products**]
   e. [**Elevate; Holcim Building Envelope**]
   f. [**GAF**]
   g. [**Hunter Panels; a Carlisle company**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Polyglass U.S.A., Inc.**]

k. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**20 psi (138 kPa)**][**25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Homasote Company**]
f. [**Hunter Panels; a Carlisle company**]
g. [**Insulfoam; a Carlisle Company**]
h. [**Johns Manville; a Berkshire Hathaway company**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

G. Perlite Board Insulation: ASTM C728, Type I, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GAF**]
b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25.4 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**]

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GAF**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Homasote Company**]
    d. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25.4 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by2438 mm)**].
4. Thickness:

    a. Base Layer: [**1 inch (25 mm)**][**2 inches (51 mm)**]

I. Cellular Glass Board Insulation: ASTM C552, Type IV, rigid, cellular glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Pittsburgh Corning Corporation**]

2. Thermal Resistance: R-value of 3.44 per **1 inch (25.4 mm)**.
3. Size: **24 by 48 inches (600 by 1219 mm)**.

J. Mineral Wool Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of **11.2-lb/cu. ft. (180-kg/cu. m)** density, and a lower layer of **7.5-lb/cu. ft. (120-kg/cu. m)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25.4 mm)**.
2. Size: **48 by 48 inches (1219 mm by 1219 mm)**.
3. Thickness:

    a. Base Layer: [**2 inches (50 mm)**]

4. Face Treatment: Bitumen coating.

K. Mineral Wool Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having **12.5-lb/cu. ft. (200-kg/cu. m)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25.4 mm)**.
2. Size: **48 by 48 inches (1219 by 1219 mm)**.
3. Thickness: **1 inch (25 mm)**.
4. Face Treatment: Bitumen coating.

L. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**]

2. Minimum Thickness: **1/4 inch (6.35 mm)**.
3. Slope:

    a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
    b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

2.7 INSULATION ACCESSORIES AND COVER BOARD

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation[**and cover boards**] to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
4. Adhesives and sealants shall comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
8. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

D. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber

insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

E. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

F. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

G. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

H. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

I. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

J. Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa).)**

K. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.

2.8 ASPHALT MATERIALS

A. Roofing Asphalt: [**ASTM D312/D312M, Type III or Type IV**][**ASTM D6152/D6152M, SEBS modified**].

B. Asphalt Primer: ASTM D41/D41M.

2.9 ELECTRONIC LEAK DETECTION (ELD) MATERIALS

A. Conductive Medium: Materials providing less than 104 ohms per square as determined in accordance with ASTM D4496 and approved by roof membrane manufacturer.

1. Electrically Conductive Primer: Water-based, non-flammable, nonmetallic, low-VOC primer[**UL listed and FM Global approved**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Detec Systems**]

2. Grounding Screen: [**Welded, stainless steel mesh**][**Aluminum screen**], for use with vector mapping system[**FM Global approved**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ILD International Leak Detection**]

3. Electrically Conductive Fabric: Non-abrasive felt.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ILD International Leak Detection**]

B. Leak Detection and Moisture-Monitoring System: Permanent, embedded leak detection and moisture-monitoring system.

1. Sensors measuring moisture content[**temperature, and vapor drive**], placed [**below roof insulation**][**over vapor barrier**] and connected to a monitoring program, with a notification indicating location of breach.
2. Sensors measuring moisture content[**temperature, and vapor drive**], in a conductive fabric placed below roof membrane and connected to a monitoring program, with a notification indicating location of breach.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Detec Systems**]
b. [**ILD International Leak Detection**]

2.10 BALLAST

A. Aggregate Ballast: [**Smooth, washed, riverbed gravel or other acceptable smooth-faced stone**][**Crushed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:

1. Size: ASTM D448, [**Size 2, ranging from 1-1/2 to 2-1/2 inches (38 to 63 mm)**][**Size 3, ranging from 1 to 2 inches (25 to 50 mm)**][**Size 4, ranging from 3/4 to 1-1/2 inches (19 to 38 mm)**].

B. Lightweight Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**2500 psi (17 MPa)**][**5000 psi (34 MPa)**], minimum.
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flex Membrane International Corp.**]
b. [**Hanover Architectural Products**]
c. [**Roofblok Limited**]
d. [**Sunny Brook Pressed Concrete, Co.**]
e. [**Tile Tech Pavers**]
f. [**Wausau Tile, Inc.**]
g. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Weight: [**18 lb/sq. ft. (90 kg/sq. m)**][**22 lb/sq. ft. (110 kg/sq. m)**].

4. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
5. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.11 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway [**pads**][**rolls**], approximately **3/16 inch (5 mm)** thick and acceptable to roofing system manufacturer.

1. Size: Approximately **36 by 60 inches (914 by 1524 mm)**.
2. Color: Contrasting with roof membrane.

B. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Sunny Brook Pressed Concrete, Co.**]
d. [**Wausau Tile, Inc.**]
e. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Weight: [**18 lb/sq. ft. (90 kg/sq. m)**][**22 lb/sq. ft. (110 kg/sq. m)**].
4. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
5. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system

manufacturer, when tested in accordance with ASTM F2170.

a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with no fewer than three tests probes.
b. Submit test reports within 24 hours after performing tests.

6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
7. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
8. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
9. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
10. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3.2 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Perform fastener-pullout tests in accordance with roof system manufacturer's written instructions.

1. Submit test result within 24 hours after performing tests.

a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

D. Install sound absorbing insulation strips in accordance with acoustical roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system in accordance with roofing system manufacturer's written instructions, [**FM Approvals' RoofNav**][**SPRI's Directory of Roof Assemblies**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with air

barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (610 mm)** in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.

    a. Locate end joints over crests of steel roof deck.

2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with recommendations in [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with [**tape**][**adhesive**].

B. Laminate Sheet: Loosely lay laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with tape.

C. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of **3-1/2 and 6 inches (90 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Seal laps by rolling.

D. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt **19 inches (483 mm)** over preceding felt.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Embed each felt in a solid mopping of hot roofing asphalt.
3. Glaze coat completed surface with hot roofing asphalt.
4. Apply hot roofing asphalt within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.

E. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.

C. Installation Over Metal Decking:

1. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**][**and with long joints continuous at right angle to flutes of decking**].

    a. Locate end joints over crests of decking.
    b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

        1) Trim insulation so that water flow is unrestricted.

    f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
    g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
    h. Loosely lay base layer of insulation units over substrate.
    i. Mechanically attach base layer of insulation[**and substrate board**] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.

        1) Fasten insulation in accordance with requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity**].
        2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

    a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
    b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.

c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
f. Trim insulation so that water flow is unrestricted.
g. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
h. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
i. Loosely lay each layer of insulation units over substrate.
j. Adhere each layer of insulation to substrate using adhesive in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

D. Installation Over Wood and Wood Panel Decking:

1. Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to [**wood**][**wood panel**] decks.

a. Fasten slip sheet in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
b. Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**].

a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).

1) Trim insulation so that water flow is unrestricted.

e. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
f. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
g. Loosely lay base layer of insulation units over substrate.
h. Mechanically attach base layer of insulation[**and substrate board**] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to [**wood**][**wood panel**] decks.

1) Fasten insulation in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

3. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

    a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
    b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

        1) Trim insulation so that water flow is unrestricted.

    f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
    g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
    h. Loosely lay each layer of insulation units over substrate.
    i. Adhere each layer of insulation to substrate using adhesive in accordance with SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

        1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
        2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
        3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

E. Installation Over Concrete Decks:

1. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**].

    a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
    b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    c. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
    d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

        1) Trim insulation so that water flow is unrestricted.

    e. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
    f. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
    g. Loosely lay base layer of insulation units over substrate.
    h. Adhere base layer of insulation to [**concrete roof deck**][**vapor retarder**] in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

        1) Prime surface of concrete deck with asphalt primer at rate of **3/4 gal./100 sq. ft. (0.3 L/sq. m)**, and allow primer to dry.

2) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
3) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
4) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

2. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

1) Trim insulation so that water flow is unrestricted.

f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
h. Loosely lay each layer of insulation units over substrate.
i. Adhere each layer of insulation to substrate using adhesive in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

F. Installation Over Cementitious Wood-Fiber Decks:

1. Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to cementitious wood-fiber decks.

a. Fasten slip sheet in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
b. Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**].

a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal

to the diameter of the drain bowl plus **24 inches (610 mm)**.

1) Trim insulation so that water flow is unrestricted.

e. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
f. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
g. Loosely lay base layer of insulation units over substrate.
h. Adhere base layer of insulation to slip sheet in accordance with SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

1) Trim insulation so that water flow is unrestricted.

f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
h. Loosely lay each layer of insulation units over substrate.
i. Adhere each layer of insulation to substrate using adhesive in accordance with SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

G. Installation Over Lightweight Insulating Concrete Decks:

1. Mechanically fasten vented base sheet to lightweight insulating concrete, with vented side down, using mechanical fasteners specifically designed and sized for fastening to lightweight insulating concrete decks.

a. Fasten vented base sheet in accordance with requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity**][**SPRI's Directory of Roof**

Assemblies for specified Wind Uplift Load Capacity].

b. Fasten vented base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**].

   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
   b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   c. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
   d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

      1) Trim insulation so that water flow is unrestricted.

   e. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
   f. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
   g. Loosely lay base layer of insulation units over substrate.
   h. Adhere base layer of insulation to vented base sheet in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

      1) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
      2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      3) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

   a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
   b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
   c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
   e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

      1) Trim insulation so that water flow is unrestricted.

   f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
   g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
   h. Loosely lay each layer of insulation units over substrate.
   i. Adhere each layer of insulation to substrate using adhesive in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.7 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

    a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

    a. Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
    b. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
    c. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

B. Install slip sheet over cover board and beneath roof membrane.

3.8 INSTALLATION OF ELD COMPONENTS

A. Install conductive medium over [**cover board**][**insulation**][**and on vertical locations to receive roof membrane**] in accordance with manufacturer's written instructions.

B. Install sensors, [**wire loop**][**conductive fabric**], connections, and accessory items required for complete system in accordance with manufacturer's written instructions.

3.9 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing, and install in accordance with roofing system manufacturer's written instructions. Unroll roof membrane and allow to relax before installing.

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions

required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

E. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

F. Apply roof membrane with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap roof membrane, and weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun. Weld seams as follows:

1. Weld Method: [**Hot air**][**Solvent**][**Hot air or solvent, as standard with membrane roofing system manufacturer**].
2. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashing.
3. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
4. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.10 INSTALLATION OF MECHANICALLY FASTENED ROOF MEMBRANE

A. Mechanically fasten roof membrane over area to receive roofing in accordance with roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. For in-splice attachment, install roof membrane with long dimension perpendicular to steel roof deck flutes.

D. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

E. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

F. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.

G. Apply roof membrane with side laps shingled with slope of roof deck where possible.

H. In-Seam Attachment: Secure one edge of CSPE sheet using fastening plates or metal battens centered within seam, and mechanically fasten CSPE sheet to roof deck.

I. Seams: Clean seam areas, overlap roof membrane, and weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

1. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun.

2. Weld seams as follows:

    a. Weld Method: [**Hot air**][**Solvent**][**Hot air or solvent, as standard with roofing system manufacturer**].

3. Test lap edges with probe to verify seam weld continuity.
4. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.
5. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
6. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.11 INSTALLATION OF LOOSELY LAID AND BALLASTED ROOF MEMBRANE

A. Loosely lay roof membrane over area to receive roofing, and install in accordance with roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Comply with requirements in ANSI/SPRI RP-4 for [**System 1**][**System 2**][**System 3**].

D. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

E. Accurately align roof membrane, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

F. Mechanically fasten or adhere perimeter of roof membrane in accordance with requirements in ANSI/SPRI RP-4.

G. [**Mechanically fasten**][**adhere**] roof membrane at corners, perimeters, and transitions in accordance with requirements in ANSI/SPRI RP-4.

1. At corners and perimeters, omit aggregate ballast leaving roof membrane exposed.
2. At corners and perimeters, adhere a second layer of roof membrane.

H. Apply roof membrane with side laps shingled with slope of deck where possible.

I. Seams: Clean seam areas, overlap roof membrane, and weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

1. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun.
2. Weld seams as follows:

    a. Weld Method: [**Hot air**][**Solvent**][**Hot air or solvent, as standard with roofing system manufacturer**].

3. Test lap edges with probe to verify seam weld continuity.
4. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.
5. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
6. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

K. Install protection mat over roof membrane, overlapping a minimum of **6 inches (150 mm)**. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of **12 inches (300 mm)**.

L. Aggregate Ballast: Apply uniformly over roof membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to roofing system. Lay ballast as roof membrane is installed, leaving roof membrane ballasted at the end of the workday.

1. Ballast Weight:

a. Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**.
b. Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**, at corners and perimeter; Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**, elsewhere.
c. Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**.

M. Roof-Paver Ballast: Install [**lightweight**][**heavyweight**] roof-paver ballast in accordance with manufacturer's written instructions.

N. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers in accordance with manufacturer's written instructions on roof corners and perimeter.

1. Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of **10 lb/sq. ft. (50 kg/sq. m)**.
2. Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of **13 lb/sq. ft. (65 kg/sq. m)**.

3.12 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates in accordance with roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.13 INSTALLATION OF WALKWAYS

A. Flexible Walkways:

1. Install flexible walkways at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **6-inch (150-mm)** clearance between adjoining pads.
3. Heat-weld to substrate or adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers in accordance with manufacturer's written instructions.

1. Install roof-paver walkways at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3 inches (75 mm)** of space between adjacent roof pavers.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Perform the following tests:

1. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Perform tests before overlying construction is placed.
b. Flood to an average depth of [**2-1/2 inches (65 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)** of clearance from top of base flashing.
c. Flood each area for [**24**][**48**][**72**] hours.
d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

2. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.

   a. Perform tests before overlying construction is placed.
   b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.
   c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

3. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M.

   a. Perform tests before overlying construction is placed.
   b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

4. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1.

   a. Perform tests before overlying construction is placed.
   b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Low-Voltage ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using low-voltage [**horizontal membrane scanning platform**][**membrane electric field vector mapping**][**vertical membrane scanning**] in accordance with ASTM D8231.

   a. Perform tests before overlying construction is placed.
   b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

6. High-Voltage Membrane Testing: Testing agency surveys entire [**roof area,**][**flashings,**][**parapet walls**] to locate discontinuity in the roof membrane using an electrically charged metal "broom head."

a. Perform tests before overlying construction is placed.
b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing system to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."

1. Repair areas where test cuts were made in accordance with roofing manufacturer's written instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

F. Roofing system will be considered defective if it does not pass tests and inspections.

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.15 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.16 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period:

8. Expiration Date:

B. AND WHEREAS Roofing Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if the Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. the Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 05 13 00B

SECTION 07 05 13 00C - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ethylene-propylene-diene-terpolymer (EPDM) roofing system.
2. Accessory roofing system materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation and accessories.
6. Cover board.
7. Electronic leak-detection (ELD) materials.
8. Ballast.
9. Walkways.

B. Section contains the installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry for wood nailers, curbs, and blocking[**and for wood-based, structural-use roof deck panels**].
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner’s insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work

interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner’s insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base and sheet flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastening spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.
8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: For the following products:

1. Roofing membrane and flashings of color required.
2. Aggregate surfacing material in gradation[**and color**] required.

3. Roof paver[**full sized,**] in each color and texture required.
4. Walkways, of color required.

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of complying with specified performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, tests performed by an independent qualified testing agency, indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not

been affected by the Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified EPDM system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified EPDM system installers**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membrane, base flashing sheet, [**ballast,**][**walkways,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**30**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membrane, base flashing sheet, [**ballast,**][**walkways,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and base flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897.

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical for that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance index (SRI) of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for application and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 ETHYLENE-PROPYLENE-DIENE-TERPOLYMER (EPDM) ROOFING SYSTEM

A. EPDM Roofing Membrane Sheet: ASTM D4637/D4637M, [**Type I, nonreinforced,**][**Type II, scrim or fabric internally reinforced,**][**self-adhering**] EPDM sheet[**with factory-applied seam tape**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Syntec Systems**]
    b. [**Elevate; Holcim Building Envelope**]
    c. [**GenFlex Roofing Systems**]
    d. [**Johns Manville; a Berkshire Hathaway company**]
    e. [**Lexcan, division of Lexsuco Corporation**]
    f. [**Mule-Hide Products Co., Inc**]
    g. [**Roofing Products International, Inc**]
    h. [**Versico Roofing Systems; Carlisle Construction Materials**]

2. Thickness: [**45 mils (1.1 mm)**][**60 mils (1.5 mm)**][**75 mils (1.9 mm)**][**90 mils (2.2 mm)**], nominal.
3. Exposed Face Color: [**Black**][**White on black**].

B. Fabric-Backed EPDM Roofing Membrane Sheet: ASTM D4637/D4637M, Type III, nonreinforced, EPDM sheet, laminated to a nonwoven polyester fabric backing except at selvages[**with factory-applied seam tape**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Syntec Systems**]
    b. [**Versico Roofing Systems; Carlisle Construction Materials**]

2. Composite Thickness: [**90 mils (2.3 mm)**][**100 mils (2.5 mm)**][**105 mils (2.7 mm)**][**115 mils (2.9 mm)**], nominal.
3. Exposed Face Color: [**Black**][**White on black**].

2.4 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

B. Base and Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as roofing membrane.

C. Protection Sheet: As recommended in writing by roofing membrane manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.

D. Slip Sheet: [**ASTM D2178/D2178M, Type IV; glass fiber; asphalt-impregnated felt**][**Manufacturer's standard, of thickness required for application**].

E. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt impregnated, fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.

F. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

G. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

H. Bonding Adhesive: Roofing membrane manufacturer's standard[**water based**].

I. Modified Asphaltic Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard modified asphalt, asbestos-free, cold-applied adhesive formulated for compatibility and use with fabric-

backed membrane roofing.

J. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.

K. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.

L. Seaming Material: [**Single-component, butyl splicing adhesive and splice cleaner**][**Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film**][**Factory-applied seam tape, width as recommended by manufacturer**].

M. Lap Sealant: Manufacturer's standard, single-component sealant[**colored to match membrane roofing**].

N. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

O. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

P. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately **1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick)**, prepunched.

Q. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing system components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

R. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

S. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

T. Liquid Roof Coating: Product specifically formulated for coating roofing membrane, as follows:

1. Type: [**Acrylic emulsion complying with ASTM D6083/D6083M**][**Chlorosulfonated polyethylene complying with ASTM D3468/D3468M**].
2. Color: [**White**][**Gray**][**Tan**][**As selected by Architect from manufacturer's full range**].

2.5 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [1/4 inch (6 mm)][1/2 inch (13 mm)][**Type X,** 5/8 inch (16 mm)].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [1/4 inch (6 mm)][3/8 inch (10 mm)][1/2 inch (13 mm)][5/8 inch (16 mm)].

C. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, 1/2 inch (13 mm) thick, having a minimum compressive strength of 80 psi (551 kPa).

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

E. Bonding Adhesive: Manufacturer's standard, designed for adhering substrate board to roof deck.

2.6 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil (1.0-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil (0.76-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers; fire-retardant polyethylene laminate; reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than 0.062 perm (3.556 ng/Pa x s x sq. m) when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.7 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured[**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV,** 1.45 lb/cu. ft. (23 kg/cu. m) **minimum**

density, 25 psi (173 kPa) minimum compressive strength][Type V, 3.00 lb/cu. ft. (48 kg/cu. m), minimum density, 100 psi (690 kPa) minimum compressive strength] square edged.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

    a. **[DuPont]**
    b. **[Kingspan Insulation LLC]**
    c. **[Owens Corning]**
    d. **[Soprema, Inc.]**

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: **[48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)]**.
4. Thickness:

    a. Base Layer: **[1-1/2 inches (38 mm)]**

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. ft. (18 kg/cu. m)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

    a. **[Atlas Molded Products, a division of Atlas Roofing Corporation]**
    b. **[Carlisle Syntec Systems]**
    c. **[Cellofoam North America, Inc.]**
    d. **[Kingspan Insulation LLC]**

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
3. Size: **[48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)]**.
4. Thickness:

    a. Base Layer: **[1-1/2 inches (38 mm)]**

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, **[Type II, 1.35 lb/cu. ft. (22 kg/cu. m)][Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)][Type IX, 1.8 lb/cu. ft. (29 kg/cu. m)]** minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

    a. **[Carlisle Syntec Systems]**
    b. **[Cellofoam North America, Inc.]**
    c. **[Insulfoam; a Carlisle Company]**

2. Facer: **[ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated,**

1/2 inch (13 mm) thick][**DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick**].

3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Elevate; Holcim Building Envelope**]
   e. [**GAF**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**IKO Industries Inc.**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Kingspan Insulation LLC**]
   k. [**Polyglass U.S.A., Inc.**]
   l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Elevate; Holcim Building Envelope**]
   e. [**GAF**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**IKO Industries Inc.**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Kingspan Insulation LLC**]
   k. [**Polyglass U.S.A., Inc.**]
   l. [**Rmax, A Business Unit of Sika Corporation**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, OSB facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].

3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].

G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GAF**]
b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per 1 inch (25 mm).
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

a. Base Layer: [1-1/2 inches (38 mm)].

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood-fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Ridge Fiberboard**]
b. [**GAF**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Homasote Company**]
e. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per 1 inch (25 mm).
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

a. Base Layer: [1 inch (25 mm)][2 inches (50 mm)].

I. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of 11.2 lb/cu. ft. (180 kg/cu. m) density, and a lower layer of 7.5 lb/cu. ft. (120 kg/cu. m) density.

1. Thermal Resistance: R-value of 3.8 per 1 inch (25 mm).
2. Size: 48 by 48 inches (1200 by 1200 mm).
3. Thickness:

a. Base Layer: [2 inches (50 mm)].

J. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having 12.5 lb/cu. ft. (200 kg/cu. m) density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.

K. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

   a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
   b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

L. General: Roof insulation accessories as recommended in writing by insulation manufacturer for intended use and compatibility with other roofing system components.

1. Insulation Adhesive: Insulation manufacturer's standard adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

   a. Modified asphaltic, asbestos-free, cold-applied adhesive.
   b. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
   c. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

2. Verify adhesives and sealants comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesives: 80 g/L.
   f. PVC Welding Compounds: 510 g/L.
   g. Other Adhesives: 250 g/L.
   h. Single-Ply Roof Membrane Sealants: 450 g/L.
   i. Nonmembrane Roof Sealants: 300 g/L.
   j. Sealant Primers for Nonporous Substrates: 250 g/L.
   k. Sealant Primers for Porous Substrates: 775 g/L.

3. Insulation Fasteners: Insulation manufacturer's standard factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation[**and cover board**] to substrate, and acceptable to roofing system manufacturer.

2.8 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

B. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with nonasphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1 inch (25 mm)** thick, with a minimum compressive strength of **80 psi (551 kPa)**.

I. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended in writing by roofing system manufacturer for application.

2.9 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.10 BALLAST

A. Aggregate Ballast: [**Smooth, washed, riverbed gravel or other acceptable smooth-faced stone**][**Crushed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:

1. Size: ASTM D448, [**Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm)**][**Size 3, ranging in size from 1 to 2 inches (25 to 50 mm)**][**Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm)**].

B. Interlocking Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**2500 psi (17 MPa)**][**5000 psi (34 MPa)**], minimum.
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Rubber Roof Pavers: Interlocking, lightweight rubber units, **24 by 24 by 2-1/4 inches (600 by 600 by 57 mm)**, **6 lb/sq. ft. (30 kg/sq. m)**; with grooved back for four-way drainage, beveled and doweled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Syntec Systems**]

2. Perimeter Securement Strip: Manufacturer's standard [**coated steel sheet channel**][**aluminum sheet channel**][**mill-finish aluminum sheet hold-down**][**coated aluminum sheet hold-down, color as selected by Architect,**] and fasteners.
3. Color: [**Black**][**Gray**][**Terra cotta**].

D. Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Coatings & Waterproofing Inc**]
    b. [**Hanover Architectural Products**]
    c. [**Roofblok Limited**]
    d. [**Sunny Brook Pressed Concrete, Co.**]
    e. [**Tile Tech Pavers**]
    f. [**Wausau Tile, Inc.**]
    g. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

1. Fasteners: **1-1/2-inch (38-mm)** stainless steel fasteners with neoprene washers.

2.11 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway [**pads**][**rolls**], approximately **3/16 inch (5 mm)** thick and acceptable to roofing system manufacturer.

1. Size: Approximately **36 by 60 inches (900 by 1500 mm)**.
2. Color: Contrasting with roof membrane.

B. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hanover Architectural Products**]
    b. [**Roofblok Limited**]
    c. [**Sunny Brook Pressed Concrete, Co.**]
    d. [**Wausau Tile, Inc.**]
    e. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's**

samples][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer when tested in accordance with ASTM F2170.

    a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
    b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roof system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

    a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof deck in accordance with roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Substrate-Joint Penetrations: Prevent adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written installation instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with tape.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
9. Loosely lay each layer of insulation over substrate.

3.7 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

    a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift**

load capacity] and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install slip sheet over cover board and beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF EPDM ROOFING MEMBRANE

A. Install roofing membrane over roof area for [**adhered**][**self-adhered**][**mechanically attached**][**loose-laid, ballasted**] application method in accordance with roofing system manufacturer's written installation instructions.

B. Unroll roofing membrane and allow it to relax before installing.

C. Start installation in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

D. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

E. Adhered Application: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply to splice area of roofing membrane.

1. In addition to adhering, mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roof area.

F. Mechanically Attached Application: Secure roofing membrane over area to receive roofing in accordance with roofing system manufacturer's written installation instructions.

1. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.

G. Loose-Laid, Ballasted Application: Comply with requirements in ANSI/SPRI RP-4 for [**System 1**][**System 2**][**System 3**].

1. [**Mechanically fasten**][**Adhere**] roofing membrane at perimeter, corners, and transitions in accordance with requirements in ANSI/SPRI RP-4.
2. At corners and perimeters, omit aggregate ballast leaving roofing membrane exposed.
3. At corners and perimeters, adhere a second layer of roofing membrane.
4. Install protection mat over roofing membrane, overlapping a minimum of **6 inches (150 mm)**. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of **12 inches (300 mm)**.
5. Aggregate Ballast: Apply uniformly over roofing membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of

damage to roofing system. Lay ballast as roof membrane is installed, leaving roof membrane ballasted at end of workday.

a. Ballast Weight:

1) Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**.
2) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**, at corners and perimeter; Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**, elsewhere.
3) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**.

6. Roof-Paver Ballast: Install [**lightweight**][**heavyweight**] roof-paver ballast in accordance with manufacturer's written instructions.
7. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers in accordance with manufacturer's written instructions on roof corners and perimeter.

a. Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of **10 lb/sq. ft. (50 kg/sq. m)**.
b. Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of **13 lb/sq. ft. (65 kg/sq. m)**.

H. Adhesive Seam Installation: Clean both faces of splice areas and apply splicing cement.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.
3. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.

I. Tape Seam Installation: Clean and prime both faces of splice areas and apply splice tape.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.

J. Factory-Applied Seam Tape Installation: Clean and prime surface to receive tape.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.

K. Repair tears, voids, and lapped seams in roofing membrane that do not comply with requirements.

L. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roofing membrane in place with clamping ring.

M. Adhere protection sheet over roofing membrane at locations indicated.

3.10 INSTALLATION OF BASE AND SHEET FLASHINGS

A. General: Install and adhere base and sheet flashings and preformed flashing accessories to substrates in accordance with roofing system manufacturer's written installation instructions.

B. Apply bonding adhesive to substrate and underside of flashings at required rate and allow to partially dry. Do not apply to seam area of flashings.

C. Flash penetrations and field-formed inside and outside corners.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping flashings to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of terminations.

E. Terminate and seal top of flashings and mechanically anchor to substrate through termination bars.

3.11 INSTALLATION OF LIQUID ROOF COATING

A. Apply coating to [**roof membrane**][**flashings**] in accordance with manufacturer's written recommendations, by spray, roller, or other suitable application method.

3.12 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products in accordance with manufacturer's written installation instructions.

1. Install flexible walkways at the following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.
   g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **6-inch (75-mm)** clearance between adjoining pads.
3. Adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers in accordance with manufacturer's written installation instructions.

1. Install roof-paver walkways at the following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.
   g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **3 inches (75 mm)** of space between adjacent roof pavers.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roofing membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

   a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

      1) Cost of retesting is Contractor's responsibility.

   b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

   a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**] of clearance from top of base flashing.
   b. Flood each area for [**24**][**48**][**72**] hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   d. Testing agency to prepare survey report indicating locations initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

   a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
   b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

   a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect[**and the Owner**] 48 hours in advance of date and time of inspection, as directed by the Owner.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.14 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner, as directed by the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.15 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:

6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and will afford reasonable opportunity for Roofing System Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract

directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 05 13 00C

SECTION 07 11 13 00 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied, cut-back-asphalt dampproofing.
2. Cold-applied, emulsified-asphalt dampproofing.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for bituminous vapor retarders under slabs-on-grade.
2. [**Section 042000 "Unit Masonry"**] [**Section 042200 "Concrete Unit Masonry"**] for mortar parge coat on masonry surfaces.
3. [**Section 071326 "Self-Adhering Sheet Waterproofing"**] [**Section 071353 "Elastomeric Sheet Waterproofing"**] [**Section 071354 "Thermoplastic Sheet Waterproofing"**] [**Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"**] [**Section 071416 "Cold Fluid-Applied Waterproofing"**] for waterproofing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed in accordance with to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide [**protection course**] [**drainage panels**] auxiliary materials recommended in writing by manufacturer of primary materials.

2.2 PERFORMANCE REQUIREMENTS

A. VOC Content: Products are to comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.3 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D4586/D4586M, Type I, Class 1, fibered.

B. Brush and Spray Coats: ASTM D4479/D4479M, Type I, fibered[**or nonfibered**].

2.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D1227/D1227M, Type II, Class 1.

B. Fibered Brush and Spray Coats: ASTM D1227/D1227M, Type II, Class 1.

C. Brush and Spray Coats: ASTM D1227/D1227M, Type III, Class 1.

2.5 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with each other and with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D41/D41M.

C. Emulsified-Asphalt Primer: ASTM D1227/D1227M, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

D. Asphalt-Coated Glass Fabric: ASTM D1668/D1668M, Type I.

E. Patching Compound: [**Epoxy or latex-modified repair mortar**] [**Asbestos-free fibered mastic**] of type recommended in writing by dampproofing manufacturer.

2.6 PROTECTION COURSE

A. Protection Course, Asphaltic: ASTM D6506/D6506M; semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

1. Thickness: Nominal [**1/8 inch (3 mm)**] [**1/4 inch (6 mm)**] [**1/8 inch (3 mm) for vertical applications; 1/4 inch (6 mm) elsewhere**].
2. Adhesive: Rubber-based solvent type recommended in writing by dampproofing manufacturer for protection course type.

B. Protection Course, Extruded-Polystyrene Board Insulation, Faced: Fan folded, faced on [**one side**] [**both sides**] with plastic film, nominal thickness 1/4 inch (6 mm), with a compressive strength of not less than 8 psi (55 kPa) when tested in accordance with ASTM D1621, and maximum water absorption by volume of 0.6 percent when tested in accordance with ASTM C272/C272M.

C. Protection Course, Extruded-Polystyrene Board Insulation, Unfaced: ASTM C578, Type X, 1/2 inch (13 mm) thick.

D. Protection Course, Molded-Polystyrene Board Insulation: ASTM C578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

E. Smooth-surfaced roll roofing complying with ASTM D6380/D6380M, Class S, Type III.

2.7 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel acceptable to dampproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core, with or without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

2.8 INSULATION DRAINAGE PANELS

A. Insulation Drainage Panels:

1. Comply with Section 072100 "Thermal Insulation" for insulation drainage panels.
2. Unfaced or geotextile-faced, extruded-polystyrene board insulation in accordance with ASTM C578, Type IV, 25-psi (173-kPa), or Type VI, 40-psi (276-kPa), minimum compressive strength; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for surface smoothness, maximum surface moisture content, and other conditions affecting performance of the Work.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with dampproofing manufacturer's written application instructions. Provide clean, dust-free, and dry substrates for dampproofing.

B. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

C. Clean substrates of projections and substances detrimental to dampproofing work; fill voids, seal joints, and remove bond breakers if any.

D. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections[**; cover with asphalt-coated glass fabric**].

3.3 INSTALLATION OF BITUMINOUS DAMPPROOFING, GENERAL

A. Comply with dampproofing manufacturer's written application instructions for cure time between coats and drying time before backfilling unless otherwise indicated.

1. Apply dampproofing to provide continuous plane of protection.

2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches (150 mm) over outside face of footing.

1. Extend dampproofing 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- (200-mm-) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch (6 mm) onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.

1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
2. Lap dampproofing at least 1/4 inch (6 mm) onto shelf angles supporting veneer.

D. Where dampproofing interior face of above-grade, exterior [**concrete**] [**masonry**] [**single-wythe masonry**] walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

3.4 INSTALLATION OF COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply [**two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat**] [**one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m)**].

B. Unparged Masonry Foundation Walls: Apply [**primer and two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat**] [**primer and one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m)**].

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Concrete Backup for Masonry Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Masonry Backup for Masonry Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.5 INSTALLATION OF COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply [**two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat**] [**one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m)**] [**one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m)**].

B. Unparged Masonry Foundation Walls: Apply [**primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat**] [**primer and one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m)**] [**primer and one trowel coat at not less than 5 gal./100 sq. ft. (2 L/sq. m)**].

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Concrete Backup for Masonry Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Masonry Backup for Masonry Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

H. Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

I. Interior Face of Exterior Masonry Walls: Where above grade and indicated to be furred and finished, apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.6 INSTALLATION OF PROTECTION COURSE

A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.
2. Install protection course [**on same day**] [**within 24 hours**] of dampproofing installation (while coating is tacky) to ensure adhesion.

3.7 INSTALLATION OF DRAINAGE PANELS

A. Molded-Sheet Drainage Panels: Install panels over completed-and-cured dampproofing, with geotextile facing away from wall substrate, in accordance with manufacturer's written instructions. Use adhesive or another method that does not penetrate dampproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. Install [**thermal insulation specified in Section 072100 "Thermal Insulation,"**] [**protection course**] before installing drainage panels.

B. Insulation Drainage Panels: Install panels over completed-and-cured dampproofing. Use adhesive or another method that does not penetrate dampproofing. Cut and fit panels to within 3/4 inch (19 mm) of projections and penetrations.

1. Ensure that drainage channels are aligned and free of obstructions.

3.8 PROTECTION

A. Protect installed drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where panels are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

B. Correct dampproofing that does not comply with requirements; repair substrates and reapply dampproofing.

END OF SECTION 07 11 13 00

Task	Specification	Specification Description
07 11 13 00	07 14 16 00	Cold Fluid-Applied Waterproofing
07 11 19 00	07 05 13 00c	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 13 13 00	07 11 13 00	Bituminous Dampproofing

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SECTION 07 13 53 00 - ELASTOMERIC SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric sheet waterproofing.
2. Accessory waterproofing system materials.
3. Protection course.
4. Molded-sheet drainage panels.
5. Electronic leak-detection (ELD) materials.
6. Plaza-deck pavers.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for forms and waterstops.
2. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
4. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.
5. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for deck expansion-joint assemblies that interface with waterproofing.

1.2 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill[**other waterproofing systems**][**under-slab vapor retarders**][**under-slab insulation**][**subdrainage systems**].

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations through waterproofing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
2. Review transitions within waterproofing system and between waterproofing and adjacent air barrier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance

properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For the following products:

1. **8-by-8-inch (200-by-200-mm)** square of waterproofing and flashing sheet.
2. **4-by-4-inch (100-by-100-mm)** square of drainage panel.
3. Plaza-deck paver, [**4-by-4-inch (100-by-100-mm) square**][**full sized**], in each color and texture required.
4. Paver pedestal assembly.

D. Sustainable Design Submittals:

1. Product Data: For waterproofing, providing information for testing in compliance with ASHRAE 160-2016.2009.
2. Product Data: For waterproofing, providing information for testing in compliance with CCR, Title 24, Part 2, Section 1202 and Ch. 14.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Installer.

B. Field quality control reports.

C. Sample warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and [**certified**][**approved**] by waterproofing manufacturer.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build for each typical waterproofing installation including[**pavers and**] accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

a. Size: [**100 sq. ft. (9.3 sq. m) in area**][**As indicated on Drawings**].
b. Description: Each type of [**wall**][**deck**][**plaza**] installation.

2. Subject to compliance with requirements, approved mockups may become part of the completed

Work if undisturbed at time of Substantial Completion.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Warranty Period: [**10**][**20**] years from date of Substantial Completion.

B. Installer's Special Warranty: Specified form, [**on warranty form at end of this Section,**] signed by Installer, covering Work of this Section, for warranty period of [**two**] years.

1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, [**plaza-deck pavers**][**including paver pedestal assembly**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Waterproofing System: Obtain waterproofing materials [**protection course**][**drainage panels**] from [**same manufacturer as waterproofing membrane**][**manufacturer approved by waterproofing membrane manufacturer**].

B. Plaza-Deck Paving: Obtain plaza-deck pavers [**and paver pedestals**] from single source from single manufacturer.

2.2 ELASTOMERIC SHEET WATERPROOFING

A. EPDM Rubber Sheet: ASTM D6134/D6134M, Type I, **60-mil- (1.5-mm-)** thick flexible sheet, unreinforced, formed from EPDM.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Coatings & Waterproofing Inc**]

2.3 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatibility with one another and with sheet waterproofing.

1. Furnish liquid-type accessory materials that comply with VOC limits of authorities having jurisdiction.

B. Concealed Sheet Flashing: Same material, construction, and thickness as sheet waterproofing or **60-mil- (1.5-mm-)** thick, uncured EPDM, as required by manufacturer.

C. Exposed Sheet Flashing: **60-mil- (1.5-mm-)** thick EPDM, cured or uncured, as required by manufacturer.

D. Bonding Adhesives: For bonding waterproofing sheets and sheet flashings to substrates and projections.

E. Splicing Cement and Cleaner: Single-component butyl splicing cement and solvent-based splice cleaner.

1. Butyl Gum Tape: **30-mil- (0.76-mm-)** thick by **6-1/4-inch- (160-mm-)** wide, uncured butyl with polyethylene release film.

F. Lap Sealant: Single-component sealant.

G. In-Seam Sealant: Single-component sealant.

H. Water-Cutoff Mastic: Butyl mastic sealant.

I. Waterproofing and Sheet-Flashing Accessories: Sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets, and other accessories recommended by waterproofing manufacturer for intended use.

J. Metal Termination Bars: Manufacturer's standard aluminum bars, approximately **1 inch (25 mm)** wide, prepunched, with fasteners.

2.4 PROTECTION COURSE

A. Protection course material of type and thickness as recommended in writing by waterproofing manufacturer for each Project condition.

2.5 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding **No. 70 (0.21-mm)** sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**American Hydrotech, Inc.**]
b. [**Carlisle Coatings & Waterproofing Inc**]
c. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
d. [**GCP Applied Technologies Inc.**]
e. [**ISI Building Products**]
f. [**Polyguard Products, Inc.**]
g. [**Urethane Polymers International, Inc. (UPI)**]

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel without Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding **No. 70 (0.21-mm)** sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Hydrotech, Inc.**]
b. [**Carlisle Coatings & Waterproofing Inc**]
c. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
d. [**GCP Applied Technologies Inc.**]
e. [**Hyload; IKO Industries, Inc.**]
f. [**ISI Building Products**]
g. [**Polyguard Products, Inc.**]
h. [**Soprema, Inc.**]
i. [**Urethane Polymers International, Inc. (UPI)**]
j. [**W. R. Meadows, Inc**]

C. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding **No. 40 (0.43-mm)** sieve, laminated to one side of the core and a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GCP Applied Technologies Inc.**]

D. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel without Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding **No. 40 (0.425-mm)** sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than

[2.8 gpm per ft. (35 L/min. per m)].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Hydrotech, Inc.**]
    b. [**Carlisle Coatings & Waterproofing Inc**]
    c. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
    d. [**Hyload; IKO Industries, Inc.**]
    e. [**Polyguard Products, Inc.**]
    f. [**Soprema, Inc.**]
    g. [**Urethane Polymers International, Inc. (UPI)**]
    h. [**W. R. Meadows, Inc**]

E. Molded-Sheet Collector-Panel System with Polymeric Film: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven-geotextile facing with an apparent opening size not exceeding **No. 40 (0.425-mm)** sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 17 gpm per ft. (112 to 211 L/min. per m)**] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GCP Applied Technologies Inc.**]
    b. [**ISI Building Products**]
    c. [**Polyguard Products, Inc.**]

F. Molded-Sheet Collector-Panel System Wrapped with Geotextile: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; wrapped with a nonwoven-geotextile facing with an apparent opening size not exceeding **No. 40 (0.425-mm)** sieve; and with a vertical flow rate through the core of [**21 to 82 gpm per ft. (261 to 1018 L/min. per m)**] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**][**of 21 gpm per ft. (261 L/min. per m)**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Coatings & Waterproofing Inc**]
    b. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
    c. [**W. R. Meadows, Inc**]

2.6 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by waterproofing membrane manufacturer.

1. Conductive medium to be located directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within waterproofing system and connected to a monitoring program, with a notification indicating location of breach.

2.7 PLAZA-DECK PAVERS

A. Plaza-Deck Pavers: [**Brick**][**Concrete**][**Asphalt-block**] pavers specified in Section 321400 "Unit Paving."

B. Stone Plaza-Deck Pavers: [**Granite**][**Limestone**][**Marble**][**Quartz-based stone**][**Slate**][**Travertine**] pavers specified in Section 321400 "Unit Paving."

C. Concrete Plaza-Deck Pavers: Solid, hydraulically pressed, standard-weight concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], manufactured for use as plaza-deck pavers; [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**] minimum compressive strength, ASTM C140/C140M; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance in accordance with ASTM C67/C67M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Coatings & Waterproofing Inc**]
b. [**Hanover Architectural Products**]
c. [**Hastings Pavement Company, LLC**]
d. [**Roofblok Limited**]
e. [**Sunny Brook Pressed Concrete, Co.**]
f. [**Tile Tech Pavers**]
g. [**Wausau Tile, Inc.**]
h. [**Westile Roofing Products; an Oldcastle company**]

2. Thickness: [**2 inches (51 mm)**][**2-3/8 inches (60 mm)**].
3. Face Size: [**12 inches (305 mm) square**][**12 by 24 inches (305 by 610 mm)**][**18 inches (457 mm) square**][**24 inches (610 mm) square**][**As indicated**].
4. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

D. Plaza-Deck Paver Metal Straps: Securement strapping fabricated from stainless steel, a minimum of **3 inches (75 mm)** wide by **0.031 inch (0.8 mm)** thick with stainless steel anchors.

E. Paver Pedestals: Paver-support assembly, [**standard with paver manufacturer**][**as named below**], including [**fixed-height**][**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**][**1/8 to 3/16 inch (3 to 5 mm)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Envirospec, Inc.**]
    b. [**Hanover Architectural Products**]
    c. [**Roofblok Limited**]
    d. [**Sunny Brook Pressed Concrete, Co.**]
    e. [**Wausau Tile, Inc.**]
    f. [**Westile Roofing Products; an Oldcastle company**]

2. Fill: As recommended in writing by pedestal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations and other conditions affecting performance of waterproofing.

1. Verify that concrete substrate has cured and aged for minimum time recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by waterproofing manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with manufacturer's written installation instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.

E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D4258.

F. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with waterproofing manufacturer's written installation instructions.

3.4 INSTALLATION OF ELASTOMERIC SHEET WATERPROOFING

A. Fully Adhered Elastomeric Sheet Waterproofing:

1. Install fully adhered sheets over entire area to receive waterproofing in accordance with manufacturer's written installation instructions and in accordance with recommendations in ASTM D6134/D6134M.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply bonding adhesive to substrates at required rate and allow it to partially dry.
4. Apply bonding adhesive to sheets and firmly adhere sheets to substrates. Do not apply bonding adhesive to splice area of sheet.
5. Install fully adhered sheets and accessory materials to tie into existing waterproofing.
6. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.
7. Horizontal Application: Apply sheets with side laps shingled with slope of deck where possible.

    a. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.

B. Partially Adhered Elastomeric Sheet Waterproofing:

1. Install partially adhered sheets over entire area to receive waterproofing in accordance with manufacturer's written installation instructions.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply bonding adhesive to the following areas of substrates and to each sheet at required rate and allow it to partially dry:

    a. Upper 25 percent of length of each sheet and **18 inches (457 mm)** around perimeter of each sheet.

4. Firmly adhere sheets to substrate. Do not apply bonding adhesive to splice area of sheet.
5. Install partially adhered sheets and accessory materials to tie into existing waterproofing.
6. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

C. Compartmented, Loosely Laid Elastomeric Sheet Waterproofing:

1. Install compartmented, loosely laid sheets over entire area to receive waterproofing in accordance with manufacturer's written installation instructions.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply continuous beads of water-cutoff mastic, of size recommended in writing by waterproofing

manufacturer, to substrates in a **60-by-60-inch (1500-by-1500-mm)** grid pattern before installing sheet.

4. Apply sheets with side laps shingled with slope of deck where possible.
5. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.
6. Install compartmented, loosely laid sheets and accessory materials to tie into existing waterproofing.
7. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

D. Cement Splice: Clean splice areas, apply splicing cement and in-seam sealant, and firmly roll side and end laps of overlapping sheets in accordance with manufacturer's written instructions to produce a splice not less than **6 inches (150 mm)** wide and to ensure a watertight seam installation. Apply lap sealant and seal edges of sheet terminations.

E. Cement and Tape Splice: Clean splice areas, apply splicing cement and butyl gum tape, and firmly roll side and end laps of overlapping sheets in accordance with manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal edges of sheet terminations.

F. Install sheet flashings and preformed flashing accessories and adhere to substrates in accordance with waterproofing manufacturer's written installation instructions.

G. Form wall flashings using exposed sheet flashing.

H. Extend deck sheet waterproofing to form wall flashings.

1. Flash penetrations and field-formed inside and outside corners with uncured sheet flashing.
2. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight installation. Apply lap sealant and seal edges of sheet-flashing terminations.

I. Cover expansion joints and discontinuous deck-to-wall or deck-to-deck joints by extending deck sheet waterproofing over joints.

J. Terminate and seal top of sheet flashings[**with mechanically anchored termination bars**].

3.5 INSTALLATION OF PROTECTION COURSE

A. Install protection course over waterproofing membrane in accordance with manufacturer's written instructions and before beginning subsequent construction operations. Minimize exposure of membrane.

1. Molded-sheet drainage panels may be used in place of a separate protection course for vertical applications when approved by waterproofing manufacturer.

3.6 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, in accordance with manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install protection course before installing drainage panels.

3.7 INSTALLATION OF PLAZA-DECK PAVERS

A. Install pavers in accordance with manufacturer's written instructions.

B. Install paver pedestals and accessories to required elevations. Adjust for final level and slope of paved surfaces.

C. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.

1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.

D. Install pavers to vary no more than **1/16 inch (1.6 mm)** in elevation between adjacent pavers and no more than **1/16 inch (1.6 mm)** from surface plane elevation of individual paver.

E. Limit variation in paving installation to within [**1/4 inch in 10 ft. (6 mm in 3 m)**] of surface plane in any direction; noncumulative.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Perform the following tests before overlying construction is placed:

1. ELD Testing: Testing agency surveys entire horizontal waterproofed area and flashings to locate discontinuities in the system assembly using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until waterproofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each completed horizontal waterproofed area for leaks, in accordance with recommendations in ASTM D5957. Install temporary containment assemblies, plug, or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)** of clearance from top of base flashing.
b. Flood each area for [**24**][**48**][**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing and flashing installations are watertight.

1) Cost of retesting is the responsibility of Contractor.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

C. Manufacturer's Field Service: Engage a [**full-time**] site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect, as directed by the Owner.

1. Final Inspection: Arrange for waterproofing system manufacturer's technical personnel to inspect system installation on completion, in presence of Architect, and to prepare inspection report.
2. Notify the Owner 48 hours in advance of date and time of inspection.
3. Repair or remove and replace components of waterproofing system where inspections indicate that they do not comply with specified requirements.

D. Additional Tests and Inspections:

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.
2. Waterproofing system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 PROTECTION, REPAIR, AND CLEANING

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Protect installed waterproofing from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 13 53 00

SECTION 07 14 13 00 - HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot fluid-applied rubberized asphalt waterproofing.
2. Accessory waterproofing system materials.
3. Protection course.
4. Molded-sheet drainage panels.
5. Insulation drainage panels.
6. Electronic leak detection (ELD) materials.
7. Plaza-deck pavers.

B. Related Requirements:

1. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
2. Section 075556 "Fluid-Applied Protected Membrane Roofing" for hot fluid-applied rubberized asphalt roofing system.
3. Section 079100 "Preformed Joint Seals" for foundation-wall expansion joints that interface with waterproofing.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
5. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.
6. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for plaza expansion-joint assemblies that interface with waterproofing.
7. Section 221423 "Storm Drainage Piping Specialties" for plaza-deck drains.
8. Section 321400 "Unit Paving" for plaza-deck pavers set on setting beds.
9. Section 334600 "Subdrainage" for molded-sheet drainage panel.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemical Compatibility: Material that will not breakdown, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength complying with requirements when in contact with another material.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill[**other waterproofing systems**] [**under-slab vapor retarders**] [**under-slab insulation**] [**subdrainage systems**].

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations through waterproofing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
2. Review transitions within waterproofing system and between waterproofing and adjacent air barrier.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings:

1. Indicate locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, expansion-joint conditions, tie-ins with adjoining waterproofing, and other termination conditions.
3. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported plaza-deck pavers.

C. Samples: For the following materials:

1. Drainage panel, 4 by 4 inch (100 by 100 mm).
2. Plaza-deck paver, [**4 by 4 inch (100 by 100 mm)**] [**full sized**].
3. Paver pedestal assembly.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**Installer**] [**testing agency**].

B. Field quality control reports.

C. Sample warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and [**certified**] [**approved**] by waterproofing manufacturer.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build mockups for each typical waterproofing installation including [**pavers and**] accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

a. Size: [**100 sq. ft. (9.3 sq. m) in area**] [**As indicated on Drawings**].
b. Description: Each type of [**wall**] [**deck**] [**plaza**] installation.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer. Protect stored materials in accordance with manufacturer's written instructions.

B. Remove and replace materials that cannot be applied within their stated shelf life.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.

1. Do not apply waterproofing to frozen, damp, or wet substrates, or when temperature is below 0 deg F (minus 18 deg C).
2. Do not apply waterproofing when snow, rain, fog, or mist are present, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.11 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or remove and replace waterproofing that fails to remain watertight within specified warranty period.

1. Warranty includes leak remediation, including repair, removal, and replacement of [**protection boards**] [**drainage panels**] [**pedestals and pavers on plaza decks**].
2. Pavers Warranty: Pavers must not dish or warp, nor crack, split, or disintegrate in freeze-thaw conditions.
3. Warranty Period: [**Five**] [**10**] years from date of Substantial Completion.

B. Installer's Special Warranty: Submit warranty [**on warranty form at end of this Section,**] signed by Installer, covering the Work of this Section, for warranty period of [**two**] years from date of Substantial Completion.

1. Warranty includes leak remediation, including repair, removal, and replacement of [**protection boards**] [**drainage panels**] [**pedestals and pavers on plaza decks**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Waterproofing System: Obtain waterproofing materials [**protection course**] [**molded-sheet drainage panels**] [**insulation drainage panels**] from [**same manufacturer as waterproofing membrane**] [**manufacturer approved by waterproofing membrane manufacturer**].

B. Plaza-Deck Paving: Obtain plaza-deck pavers [**and paver pedestal assembly**] from single source from single manufacturer for consistent quality in appearance and physical properties.

2.2 HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

A. Single-Component Waterproofing: [**Reinforced**] [**Unreinforced**]; 100 percent solids rubberized asphalt membrane.

1. Flow: 1/8 inch (3.2 mm) maximum at 140 deg F (60 deg C) in accordance with ASTM D5329.
2. Flash Point: Not less than 500 deg F (260 deg C) and not less than 77 deg F (25 deg C) above the manufacturer's maximum recommended application temperature in accordance with ASTM D92.
3. Water-Vapor Permeance: 0.027 perm in accordance with ASTM E96/E96M, Procedure E.
4. Crack Bridging Capability: No cracking, splitting, or loss of adhesion in accordance with ASTM C1305/C1305M.

2.3 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.

B. Asphalt Primer: ASTM D41/D41M.

C. Elastomeric Sheet Flashing: Manufacturer's standard uncured neoprene flashing sheet.

1. Adhesive: Manufacturer's standard contact adhesive.

D. SBS-Modified Bituminous Sheet Flashing: ASTM D6164/D6164M, Grade G, Type I or Type II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, [**white**] [**gray**] [**tan**].

1. Backer Sheet: ASTM D6164/D6164M, Grade S, Type I or Type II, polyester-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified.

E. Metal Termination Bars: Manufacturer's standard, predrilled, stainless steel or aluminum termination bars; approximately 1 by 1/8 inch (25 by 3.2 mm) thick; with stainless steel anchors.

F. Reinforcing Fabric: Manufacturer's standard fiberglass mesh or spun-bonded polyester fabric.

2.4 PROTECTION COURSE

A. Protection Course, Asphaltic: ASTM D6506/D6506M; semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:

1. Thickness: Nominal [**1/8 inch (3.2 mm)**] [**1/4 inch (6.4 mm)**] [**1/8 inch (3.2 mm) for vertical applications; 1/4 inch (6.4 mm) elsewhere**].

B. Protection Course, Extruded-Polystyrene Board Insulation, Faced: Fan folded, faced on [**one side**] [**both sides**] with plastic film, nominal thickness 1/4 inch (6.4 mm), with compressive strength of not less than 8 psi (55 kPa) when tested in accordance with ASTM D1621, and maximum water absorption by volume of 0.6 percent when tested in accordance with ASTM C272/C272M.

C. Protection Course, Extruded-Polystyrene Board Insulation, Unfaced: ASTM C578, Type X, 1/2 inch (13 mm) thick.

D. Protection Course, Molded-Polystyrene Board Insulation: ASTM C578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

2.5 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

C. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43 mm) sieve, laminated to one side of the core and a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

D. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43 mm) sieve, laminated to one side of the core, without a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

E. Molded-Sheet Collector-Panel System with Polymeric Film: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of

[9 to 17 gpm per ft. (112 to 211 L/min. per m)] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

F. Molded-Sheet Collector-Panel System Wrapped with Geotextile: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; wrapped with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425 mm) sieve; and with a vertical flow rate through the core of [21 to 97 gpm per ft. (261 to 1197 L/min. per m)] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**] [**of** 21 gpm per ft. (261 L/min. per m)]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

2.6 INSULATION DRAINAGE PANELS

A. Unfaced, Wall-Insulation Drainage Panels, Type IV: ASTM C578, 25 psi (173 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplapped or channel edges and with one side having grooved drainage channels.

B. Geotextile-Faced, Wall-Insulation Drainage Panels, Type IV: ASTM C578, 25 psi (173 kPa) minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.

C. Unfaced, Wall-Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplapped or channel edges and with one side having grooved drainage channels.

D. Geotextile-Faced, Wall-Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.

E. Unfaced, Plaza-Deck, Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

F. Geotextile-Faced, Plaza-Deck, Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven geotextile filter fabric.

G. Unfaced, Plaza-Deck, Insulation Drainage Panels, Type VII: ASTM C578, 60 psi (414 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

H. Geotextile-Faced, Plaza-Deck, Insulation Drainage Panels, Type VII: ASTM C578, 60 psi (414 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven geotextile filter fabric.

I. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C578, Type VI, 1.8 lb/cu. ft. (29 kg/cu. m) minimum density, 40 psi (276 kPa) minimum compressive strength, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping, [3/8 inch (9 mm) **thick,** 4.5 lb/sq. ft. (19.5 kg/sq. m)] [15/16 inch (23 mm) **thick,** 11 lb/sq. ft. (53.7 kg/sq. m)].

2.7 ELECTRONIC LEAK DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by waterproofing membrane manufacturer.

1. Conductive medium to be located directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within waterproofing system and connected to a monitoring program, with a notification indicating location of breach.

2.8 PLAZA-DECK PAVERS

A. Plaza-Deck Pavers: [**Brick**] [**Concrete**] [**Asphalt-block**] pavers specified in Section 321400 "Unit Paving."

B. Stone Plaza-Deck Pavers: [**Granite**] [**Limestone**] [**Marble**] [**Quartz-based stone**] [**Slate**] [**Travertine**] pavers specified in Section 321400 "Unit Paving."

C. Concrete Plaza-Deck Pavers: Solid, hydraulically pressed, standard-weight concrete units, [**square edged**] [**with top edges beveled 3/16 inch (5 mm)**], manufactured for use as plaza-deck pavers; [**7500 psi (52 MPa)**] [**6500 psi (45 MPa)**] minimum compressive strength when tested in accordance with ASTM C140/C140M; absorption not greater than 5 percent when tested in accordance with ASTM C140/C140M; and no breakage and maximum 1 percent mass loss, freeze-thaw resistance, when tested in accordance with ASTM C67/C67M.

1. Thickness: [**2 inches (51 mm)**] [**2-3/8 inches (60 mm)**] .
2. Face Size: [**12 inches (305 mm) square**] [**12 by 24 inches (305 by 610 mm)**] [**18 inches (457 mm) square**] [**24 inches (610 mm) square**] [**As indicated**] .
3. Color and Texture: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].
4. Provide pavers with holes or slots to permit rain flowing across plaza to drain through grate into roof drains.

D. Plaza-Deck Paver Metal Straps: Securement strapping fabricated from stainless steel, a minimum of 3 inches (75 mm) wide by 0.031 inch (0.8 mm) thick with stainless steel anchors.

E. Paver Pedestals: Paver-support assembly, [**standard with paver manufacturer**] [**as named below**], including [**fixed-height**] [**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3.2 mm)**] [**3/16 inch (5 mm)**] [**1/8 to 3/16 inch (3.2 to 5 mm)**].

1. Fill: As recommended in writing by pedestal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that concrete has cured and aged for minimum time period as recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits as recommended in writing by waterproofing manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates in accordance with waterproofing manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

F. Coordinate with the Owner for impact to air-intake equipment in the vicinity of the Work. Cover or filter air-intake louvers before proceeding with work that could affect indoor air quality or that could activate smoke detectors in the ductwork.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**].

3.4 TREATMENT OF JOINTS AND CRACKS

A. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and to recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**]. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.

1. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches (150 mm) on each side of moving joints and cracks, or

joints and cracks exceeding 1/8 inch (3.2 mm) thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied rubberized asphalt over elastomeric sheet.

2. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches (150 mm) on each side of nonmoving joints and cracks not exceeding 1/8 inch (3.2 mm) thick, and beyond roof drains and penetrations.

    a. Apply second layer of hot fluid-applied rubberized asphalt over reinforcing fabric.

B. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches (150 mm) on each side of joints and adhere to substrates in a layer of hot rubberized asphalt. Apply second layer of hot fluid-applied rubberized asphalt over elastomeric sheet.

3.5 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with waterproofing manufacturer's written installation instructions.

3.6 INSTALLATION OF SHEET FLASHING

A. Install sheet flashing at terminations of waterproofing membrane in accordance with manufacturer's written instructions.

B. Prime substrate with asphalt primer.

C. Install sheet flashing and adhere to deck and wall substrates in a layer of hot rubberized asphalt.

D. Bond modified bituminous flashing sheet to substrate as follows:

1. Adhere SBS-modified bituminous[**backer sheet and**] flashing sheet to substrate in a layer of hot fluid-applied rubberized asphalt, or torch apply APP-modified bituminous flashing sheet to substrate as standard with manufacturer.

E. Extend sheet flashing up walls or parapets a minimum of 8 inches (200 mm) above plaza-deck pavers and 6 inches (150 mm) onto deck to be waterproofed.

F. Install termination bars and mechanically fasten to top of sheet flashing at terminations and perimeter of waterproofing.

3.7 INSTALLATION OF HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

A. General: Apply waterproofing in accordance with manufacturer's written instructions.

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate at manufacturer's recommended rate and allow it to dry.

D. Heat rubberized asphalt in accordance with manufacturer's written instructions.

1. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.

E. Unreinforced Waterproofing Membrane Applications: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to form a uniform, unreinforced, seamless membrane, [**180-mil (4.5-mm) minimum thickness**] [**180-mil (4.5-mm) average thickness, but not less than 125 mils (3.2 mm) thick**].

F. Reinforced Waterproofing Membrane Applications: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to a thickness of 90 mils (2.3 mm); embed reinforcing fabric, overlapping sheets 2 inches (50 mm); spread another 125-mil- (3.2-mm-) thick layer to provide a uniform, reinforced, seamless membrane 215 mils (5.5 mm) thick.

G. Cure waterproofing, taking care to prevent contamination and damage to membrane.

3.8 INSTALLATION OF PROTECTION COURSE

A. Cover waterproofing with protection course with overlapped joints before membrane is subject to [**backfilling**] [**construction or vehicular traffic**].

1. For horizontal applications, install protection course loose laid over fully cured membrane.
2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.

3.9 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels in accordance with waterproofing manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing.

B. Molded-Sheet Collector-Panel System: Install in accordance with waterproofing manufacturer's written instructions. Connect to piped subdrainage system specified in Section 334600 "Subdrainage."

3.10 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation drainage panel in adhesive or tape applied in accordance with manufacturer's written instructions.

D. On horizontal surfaces, loosely lay insulation drainage panel in accordance with manufacturer's written instructions. Stagger end joints and tightly abut board insulation.

3.11 INSTALLATION OF PLAZA-DECK PAVERS

A. Install pavers in accordance with manufacturer's written instructions.

B. Install paver pedestals and accessories to required elevations in accordance with manufacturer's written installation instructions. Adjust for final level and slope of paved surfaces.

C. [**Loosely lay pavers on pedestals**] [**Seat pavers on pedestals and install bolted plate in accordance with manufacturer's written installation instructions**], maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.

1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.

D. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.

E. Limit variation in paving installation to within [**1/4 inch in 10 ft. (6.4 mm in 3 m)**] of surface plane in any direction; noncumulative.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing agency to verify thickness of waterproofing during application for each [**600 sq. ft. (56 sq. m)**] of installed waterproofing or part thereof.

B. Perform the following tests before overlying construction is placed:

1. ELD Testing: Testing agency surveys entire horizontal waterproofed area and flashings to locate discontinuities in the system assembly using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until waterproofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each completed horizontal waterproofed area for leaks, in accordance with recommendations in ASTM D5957. Install temporary containment assemblies, plug, or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain 2 inches (50 mm) of clearance from top of base flashing.
b. Flood each area for [**24**] [**48**] [**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

C. Manufacturer's Field Service: Engage a [**full-time**] site representative qualified by waterproofing system manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect, as directed by the Owner.

1. Final Inspection: Arrange for waterproofing system manufacturer's technical personnel to inspect system installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.
2. Notify the Owner 48 hours in advance of date and time of inspection.
3. Repair or remove and replace components of waterproofing system where inspections indicate that they do not comply with specified requirements.

D. Additional Tests and Inspections:

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.
2. Waterproofing system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing system from damage and wear during remainder of construction period.

B. Protect installed [**protection course**] [**drainage panels**] from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where material is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing system that does not comply with requirements, repair substrates, and repair or reinstall waterproofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 14 13 00

SECTION 07 14 16 00 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyether waterproofing.
2. Polyurethane waterproofing.
3. Polymer rubber gel waterproofing.
4. Rubber waterproofing.
5. Cold-applied rubberized asphalt waterproofing.
6. Latex waterproofing.
7. Accessory waterproofing system materials.
8. Protection course.
9. Molded-sheet drainage panels.
10. Insulation drainage panels.
11. Electronic leak-detection (ELD) materials.
12. Plaza-deck pavers.

B. Related Requirements:

1. Section 071800 "Traffic Coatings" for exposed, fluid-applied membrane with an integral wearing surface.
2. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
4. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior expansion-joint assemblies that interface with waterproofing.
5. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for deck expansion-joint assemblies that interface with waterproofing.
6. Section 221423 "Storm Drainage Piping Specialties" for plaza-deck drains.
7. Section 321400 "Unit Paving" for plaza-deck pavers set on setting beds.
8. Section 334600 "Subdrainage" for molded-sheet drainage panels.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemical Compatibility: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength complying with requirements when in contact with another material.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill[**other waterproofing systems**] [**under-slab vapor retarders**] [**under-slab insulation**] [**subdrainage systems**].

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations in waterproofing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements, including, but not limited to, the following:

a. Surface preparation specified in other Sections.
b. Minimum concrete curing period.
c. Forecasted weather conditions.
d. Special details and sheet flashings.
e. Repairs.
f. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings:

1. Indicate locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, expansion-joint conditions, tie-ins with adjoining waterproofing, and other termination conditions.
3. Include setting drawings indicating layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For the following materials:

1. Cured sample of waterproofing membrane on suitable rigid substrate, 8 by 8 inches (200 by 200 mm).
2. Flashing sheet, 8 by 8 inches (200 by 200 mm).
3. Membrane-reinforcing fabric, 8 by 8 inches (200 by 200 mm).
4. Drainage panel, 4 by 4 inches (100 by 100 mm).
5. Plaza-deck paver, [**4 by 4 inches (100 by 100 mm)**] [**full sized**].
6. Paver pedestal assembly.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**] [**testing agency**].

B. Field quality control reports.

C. Sample warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and [**certified**] [**approved**] by waterproofing manufacturer.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build mockup for each typical waterproofing installation, including [**pavers and**] accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

a. Size: [**100 sq. ft. (9.3 sq. m) in area**] [**As indicated on Drawings**].
b. Description: Each type of [**wall**] [**deck**] [**plaza deck**] installation.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer. Protect stored materials in accordance with manufacturer's written instructions.

B. Remove and replace materials that cannot be applied within their stated shelf life.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.

1. Do not apply waterproofing to frozen, damp, or wet substrates, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
2. Do not apply waterproofing when snow, rain, fog, or mist are present, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.11 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or remove and replace waterproofing that fails to remain watertight within specified warranty period.

1. Warranty includes leak remediation, including repair, removal, and replacement of [**protection course**] [**drainage panels**] [**pedestals and pavers on plaza decks**].
2. Pavers Warranty: Pavers must not dish or warp, nor crack, split, or disintegrate in freeze-thaw conditions.
3. Warranty Period: [**Five**] [**10**] years from date of Substantial Completion.

B. Installer's Special Warranty: Submit warranty [**on warranty form at end of this Section,**] signed by Installer, covering the Work of this Section, for warranty period of [**two**] years from date of Substantial Completion.

1. Warranty includes leak remediation, including repair, removal, and replacement of [**protection course**] [**drainage panels**] [**pedestals and pavers on plaza decks**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Waterproofing System: Obtain waterproofing materials [**protection course**] [**molded-sheet drainage panels**] [**insulation drainage panels**] from [**same manufacturer as waterproofing membrane**] [**manufacturer approved by waterproofing membrane manufacturer**].

B. Plaza-Deck Paving: Obtain plaza-deck pavers[**and paver pedestal assembly**] from single source from single manufacturer for consistent quality in appearance and physical properties.

2.2 POLYETHER WATERPROOFING

A. STPE Waterproofing: Single-component, silyl-terminated polyether[**complying with ASTM C836/C836M**].

1. Tensile Strength: 900 psi (6.2 MPa) minimum; ASTM D638.
2. Elongation at Break: 300 percent minimum; ASTM D638.
3. Water Vapor Permeance: 0.1 perm (5.7 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.
4. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

2.3 POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing: [**ASTM C836/C836M**] [**coal-tar free**].

B. Single-Component, Reinforced, Modified Polyurethane Waterproofing: [**ASTM C836/C836M**] [**coal-tar free**].

C. Two-Component, Polyurethane Waterproofing:[**ASTM C836/C836M.**]

D. Two-Component, Reinforced, Polyurethane Waterproofing:[**ASTM C836/C836M.**]

E. PUMA Waterproofing: Two-component, polyurethane methacrylate; ASTM C1305/C1305M.

1. Tensile Strength: 900 psi (6.2 MPa) minimum; ASTM D638.
2. Elongation at Break: 400 percent minimum; ASTM D638.
3. Water Vapor Permeance: 0.003 perm (0.172 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.

F. PMMA Waterproofing: Two-component, polymethyl methacrylate; ASTM C836/C836M, reinforced with polyester fleece layer.

1. Thickness: Not less than 90 mils; ASTM D5147/D5147M (Section 6).
2. Elongation at Peak Load: Average 35%; ASTM D5147/D5147M (Section 7).
3. Tear Strength: Not less than 90 lbf (0.4 kN); ASTM D5147/D5147M (Section 8).
4. Low-Temperature Flexibility: Minus 4 deg F (minus 20 deg C); ASTM D5147/D5147M (Section 12).

2.4 POLYMER RUBBER GEL WATERPROOFING

A. Single-Component, Polymer-Modified Rubber Gel (PRG) Waterproofing: Spray-applied, composite system composed of non-Newtonian thixotropic, noncuring, flexible, self-healing polymer rubberized bituminous emulsion, polyethylene sheet membrane, and other proprietary ancillary components.

1. Solids Content: 99 percent minimum; ASTM D1353/D1353M.
2. Puncture Resistance: Minimum 90 lb.; ASTM D1709.
3. Hardness: Minimum 100; ASTM C836/C836M.
4. Tensile Strength: Minimum 50 lb., ASTM D412.
5. Elongation Percentage: Minimum 300; ASTM C1135.
6. Adhesion to Concrete: Rating of 1 (Excellent); ASTM D412.
7. Water Vapor Permeance: 0.005 perm, maximum, ASTM E96/E96M.

B. Single-Component, Polymer-Modified Rubber Gel (PRG) Injection Restorative Membrane Waterproofing System: Elastomeric, noncuring, flexible, self-healing, chemical-resistant polymer rubberized bituminous emulsion formulated for repairing and restoring damaged waterproofing membrane systems.

1. Solids Content: Minimum 75 percent; ASTM D1353/D1353M.
2. Viscosity at Application: Minimum 150,000 cP; ASTM D2196.

2.5 RUBBER WATERPROOFING

A. Single-Component, Rubber Waterproofing: ASTM C836/C836M; solvent based; coal-tar free.

1. Hydrostatic-Head Resistance: 69.3 ft. (21.1 m) minimum; [**ASTM C1306/C1306M**] [**ASTM E154/E154M**].

B. Two-Component, Rubber Waterproofing: ASTM C836/C836M; coal-tar free.

1. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

C. Two-Component, Reinforced, Rubber Waterproofing: ASTM C836/C836M; coal-tar free.

1. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

2.6 COLD-APPLIED RUBBERIZED ASPHALT WATERPROOFING

A. Single-Component, Rubberized Asphalt Waterproofing: [**ASTM C836/C836M**] water-based, polymer-modified rubberized asphalt waterproofing.

1. Elongation at Break: 360 percent minimum; ASTM D412.
2. Water Vapor Permeance: 0.03 perm (1.72 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.
3. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

B. Single-Component, Reinforced, Rubberized Asphalt Waterproofing: [**ASTM C836/C836M**]water-based, polymer-modified rubberized asphalt waterproofing.

1. Elongation at Break: 360 percent minimum; ASTM D412.
2. Water Vapor Permeance: 0.03 perm (1.72 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.
3. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

C. Two-Component, Rubberized Asphalt Waterproofing: Water-based, polymer-modified rubberized asphalt.

1. Elongation at Break: 360 percent minimum; ASTM D412.

2.7 LATEX WATERPROOFING

A. Latex-Based Waterproof Coating with Biocide:

1. Hydrostatic Pressure Resistance: [**10 psi (69 kPa)**] [**12 psi (83 kPa)**] [**15 psi (103 kPa)**] [**20 psi (140 kPa)**] minimum; ASTM D7088.
2. Resistance to Wind-Driven Rain: [**98 mph (44 m/s)**] [**140 mph (63 m/s)**] minimum; ASTM D6904.

2.8 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.

B. Primer: Liquid [**waterborne**] [**solvent-borne**] primer as recommended in writing for substrate by waterproofing manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner as recommended in writing for substrate by waterproofing manufacturer.

D. Sheet Flashing: Manufacturer's standard flashing sheet.

1. Adhesive: Manufacturer's standard contact adhesive.

E. Metal Termination Bars: Manufacturer's standard, predrilled, stainless steel or aluminum termination bars; approximately 1 by 1/8 inch (25 by 3.2 mm) thick; with stainless steel anchors.

F. Reinforcing Fabric: Manufacturer's standard fiberglass mesh or spun-bonded polyester fabric.

G. Detailing Seam Tape: Manufacturer's standard detailing tape.

H. Joint Sealant: [**Single-component**] [**Multicomponent**] polyurethane sealant, compatible with waterproofing; [**ASTM C920, Type M, Class 25 or greater; Grade NS for sloping and vertical applications and Grade P for deck applications; Use NT exposure**] [**as specified in Section 079200 "Joint Sealants"**]; and as recommended in writing by waterproofing manufacturer for substrate and joint conditions.

I. Backer Rod: Closed-cell polyethylene foam.

2.9 PROTECTION COURSE

A. Protection Course, Asphaltic: ASTM D6506/D6506M; semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners:

1. Thickness: Nominal [**1/8 inch (3.2 mm)**] [**1/4 inch (6.4 mm)**] [**1/8 inch (3.2 mm) for vertical applications; 1/4 inch (6.4 mm) elsewhere**].

B. Protection Course, Extruded-Polystyrene Board Insulation, Faced: Fan folded, faced on [**one side**] [**both sides**] with plastic film, nominal thickness 1/4 inch (6.4 mm), with compressive strength of not less than 8 psi (55 kPa) when tested in accordance with ASTM D1621/D1621M, and maximum water absorption by volume of 0.6 percent when tested in accordance with ASTM C272/C272M.

C. Protection Course, Extruded-Polystyrene Board Insulation, Unfaced: ASTM C578, Type X, 1/2 inch (13 mm) thick.

D. Protection Course, Molded-Polystyrene Board Insulation: ASTM C578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

2.10 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a needle-punched nonwoven-geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

C. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43 mm) sieve, laminated to one side of the core and a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

D. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-

plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43 mm) sieve, laminated to one side of the core, without a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

E. Molded-Sheet Collector-Panel System with Polymeric Film: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 17 gpm per ft. (112 to 211 L/min. per m)**] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

F. Molded-Sheet Collector-Panel System Wrapped with Geotextile: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; wrapped with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425 mm) sieve; and with a vertical flow rate through the core of [**21 to 97 gpm per ft. (261 to 1197 L/min. per m)**] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**] [**of 21 gpm per ft. (261 L/min. per m)**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

2.11 INSULATION DRAINAGE PANELS

A. Unfaced, Wall-Insulation Drainage Panels, Type IV: ASTM C578, 25 psi (173 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplapped or channel edges and with one side having grooved drainage channels.

B. Geotextile-Faced, Wall-Insulation Drainage Panels, Type IV: ASTM C578, 25 psi (173 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven-geotextile filter fabric.

C. Unfaced, Wall-Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplapped or channel edges and with one side having grooved drainage channels.

D. Geotextile-Faced, Wall-Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven-geotextile filter fabric.

E. Unfaced, Plaza-Deck, Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

F. Geotextile-Faced, Plaza-Deck, Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven-geotextile filter fabric.

G. Unfaced, Plaza-Deck, Insulation Drainage Panels, Type VII: ASTM C578, 60 psi (414 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

H. Geotextile-Faced, Plaza-Deck, Insulation Drainage Panels, Type VII: ASTM C578, 60 psi (414 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven-geotextile filter fabric.

I. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C578, Type VI, 1.8 lb/cu. ft. (29 kg/cu. m) minimum density, 40 psi (276 kPa) minimum compressive strength, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping, [**3/8 inch (9 mm) thick, 4.5 lb/sq. ft. (19.5 kg/sq. m)**] [**15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m)**].

2.12 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by waterproofing membrane manufacturer.

1. Conductive medium to be located directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within waterproofing system and connected to a monitoring program, with a notification indicating location of breach.

2.13 PLAZA-DECK PAVERS

A. Plaza-Deck Pavers: [**Brick**] [**Concrete**] [**Asphalt-block**] pavers specified in Section 321400 "Unit Paving."

B. Stone Plaza-Deck Pavers: [**Granite**] [**Limestone**] [**Marble**] [**Quartz-based stone**] [**Slate**] [**Travertine**] pavers specified in Section 321400 "Unit Paving."

C. Concrete Plaza-Deck Pavers: Solid, hydraulically pressed, standard-weight concrete units, [**square edged**] [**with top edges beveled 3/16 inch (5 mm)**], manufactured for use as plaza-deck pavers; [**7500 psi (52 MPa)**] [**6500 psi (45 MPa)**] minimum compressive strength when tested in accordance with ASTM C140/C140M; absorption not greater than 5 percent when tested in accordance with ASTM C140/C140M; and no breakage and maximum 1 percent mass loss, freeze-thaw resistance, when tested in accordance with ASTM C67/C67M.

1. Thickness: [**2 inches (50 mm)**] [**2-3/8 inches (60 mm)**].
2. Face Size: [**12 inches (305 mm) square**] [**12 by 24 inches (305 by 610 mm)**] [**18 inches (457 mm) square**] [**24 inches (610 mm) square**] [**As indicated**].
3. Color and Texture: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.
4. Provide pavers with holes or slots to permit rain flowing across plaza to drain through grate into roof drains.

D. Plaza-Deck Paver Metal Straps: Securement strapping fabricated from stainless steel, a minimum of 3 inches (75 mm) wide by 0.031 inch (0.8 mm) thick with stainless steel anchors.

E. Paver Pedestals: Paver-support assembly, [**standard with paver manufacturer**] [**as named below**], including [**fixed-height**] [**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3.2 mm)**] [**3/16 inch (5 mm)**] [**1/8 to 3/16 inch (3.2 to 5 mm)**].

1. Fill: As recommended in writing by pedestal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that concrete has cured and aged for minimum time period as recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits as recommended in writing by waterproofing manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with waterproofing manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

F. Coordinate with the Owner for impact to air-intake equipment in the vicinity of the Work. Cover or filter air-intake louvers before proceeding with work that could affect indoor air quality or that could activate smoke detectors in the ductwork.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**].

3.4 TREATMENT OF JOINTS AND CRACKS

A. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**]. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.

1. Comply with ASTM C1193 for joint-sealant installation.
2. Apply bond breaker on sealant surface, beneath preparation strip.
3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least 6 inches (150 mm) wide along each side of joint. Apply waterproofing in two separate applications and embed a joint-reinforcing strip in first preparation coat.

B. Install sheet flashing and bond to deck and wall substrates where required in accordance with waterproofing manufacturer's written instructions.

1. Extend sheet flashings for [**4 inches (100 mm)**] onto perpendicular surfaces and items penetrating substrate.

3.5 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with waterproofing manufacturer's written installation instructions.

3.6 INSTALLATION OF COLD FLUID-APPLIED WATERPROOFING

A. General: Apply waterproofing in accordance with manufacturer's written instructions and to recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**].

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate at manufacturer's recommended rate and allow it to dry.

D. Unreinforced Waterproofing Membrane Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a minimum dry film thickness of [**60 mils (1.5 mm)**] [**90 mils (2.25 mm)**] [**120 mils (3 mm)**] .
2. Apply waterproofing to prepared wall terminations and vertical surfaces.
3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).

E. Reinforced Waterproofing Membrane Applications: Mix materials and apply waterproofing by roller, notched squeegee, trowel, or other suitable application method.

1. Apply first coat of waterproofing, embed membrane-reinforcing fabric, and apply second coat of waterproofing to completely saturate reinforcing fabric and to obtain a seamless reinforced

membrane free of entrapped gases and pinholes, with an average dry film total thickness of [**70 mils (1.8 mm)**] [**80 mils (2 mm)**] [**90 mils (2.3 mm)**] [**120 mils (3 mm)**].

2. Apply reinforced waterproofing to prepared wall terminations and vertical surfaces.
3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).

F. Cure waterproofing, taking care to prevent contamination and damage to membrane.

3.7 INSTALLATION OF PROTECTION COURSE

A. Cover waterproofing with protection course with butted joints before membrane is subject to [**backfilling**] [**construction or vehicular traffic**].

1. For horizontal applications, install protection course loose laid over fully cured membrane.
2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.

3.8 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels in accordance with waterproofing manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing.

B. Molded-Sheet Collector-Panel System: Install in accordance with waterproofing manufacturer's written instructions. Connect to piped subdrainage system specified in Section 334600 "Subdrainage."

3.9 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied in accordance with manufacturer's written instructions.

D. On horizontal surfaces, loosely lay insulation drainage panels in accordance with manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.10 INSTALLATION OF PLAZA-DECK PAVERS

A. Install pavers in accordance with manufacturer's written instructions.

B. Install paver pedestals and accessories to required elevations. Adjust for final level and slope of paved surface.

C. [**Loosely lay pavers on pedestals**] [**Seat pavers on pedestals and install bolted plate in accordance with manufacturer's written installation instructions**], maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paver assembly. Align joint patterns parallel in each direction.

1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.

D. Install pavers to vary no more than 1/16 inch (1.6 mm) in elevation between adjacent pavers and no more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.

E. Limit variation in paver installation to within [**1/4 inch in 10 ft. (6.4 mm in 3 m)**] of surface plane in any direction; noncumulative.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections:

1. Testing agency to verify thickness of waterproofing during application for each [**600 sq. ft. (56 sq. m)**] of installed waterproofing or part thereof.

B. Perform the following tests before overlying construction is placed:

1. ELD Testing: Testing agency surveys entire horizontal waterproofed area and flashings to locate discontinuities in the system assembly using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until waterproofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each completed horizontal waterproofed area for leaks, in accordance with recommendations in ASTM D5957. Install temporary containment assemblies, plug, or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain 2 inches (50 mm) of clearance from top of base flashing.
b. Flood each area for [**24**] [**48**] [**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing and flashing installations are watertight.

1) Cost of retesting is the responsibility of Contractor.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

C. Manufacturer's Field Service: Engage a [**full-time**] site representative qualified by waterproofing system manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect, as directed by the Owner.

1. Final Inspection: Arrange for waterproofing system manufacturer's technical personnel to inspect system installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.
2. Notify the Owner 48 hours in advance of date and time of inspection, as directed by the Owner.

3. Repair or remove and replace components of waterproofing system where inspections indicate that they do not comply with specified requirements.

D. Additional Tests and Inspections:

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.
2. Waterproofing system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.12 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing system from damage and wear during remainder of construction period.

B. Protect installed [**protection course**] [**drainage panels**] from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where material is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing system that does not comply with requirements, repair substrates, and repair or reinstall waterproofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 14 16 00

SECTION 07 16 13 00 - POLYMER MODIFIED CEMENT WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Prepackaged, polymer-modified cement waterproofing.
2. Field-mixed, polymer-modified cement waterproofing.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for [**concrete slabs serving as protective topping for waterproofing and**]the finishing of concrete walls and slabs to receive waterproofing.
2. Section 099726 "Cementitious Coatings" for polymer-modified cementitious coatings used primarily for decorative purposes.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemically Compatible: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength, complying with specified performance requirements when in contact with another material.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation Work, including other waterproofing systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements including, but not limited to, the following:

a. Minimum concrete curing period.
b. Forecasted weather conditions.
c. Repairs.
d. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and installation instructions.

B. Samples for Initial Selection: For each type of exposed product.

1. Include Samples of available color selection.

C. Samples for Verification: For each type of exposed waterproofing indicated, in manufacturer's standard sizes.

D. Sustainable Design Submittals:

1. Product Data: For waterproofing, providing information for testing in compliance with ASHRAE 160-2016.2009.
2. Product Data: For waterproofing, providing information for testing in compliance with CCR, Title 24, Part 2, Section 1202 and Ch. 14.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statement: For Applicator.

B. Product Test Reports: For each product formulation, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Applicator Qualifications: Entity that employs applicators and supervisors who are trained[**and approved**] by waterproofing manufacturer in applying polymer-modified cement waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged waterproofing materials in original undamaged containers, with manufacturer's labels and seals intact.

B. Take necessary precautions to keep products clean, dry, and free of damage.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit polymer-modified cement waterproofing to be applied in accordance with manufacturer's written instructions.

B. Proceed with waterproofing work only after installation of pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

C. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at **40 deg F (4.4 deg C)** or above for at least 48 hours before, during work, and cure period, and space is well ventilated and kept free of water.

PART 2 - PRODUCTS

2.1 PREPACKAGED, POLYMER-MODIFIED CEMENT WATERPROOFING

A. Negative-Side, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with [**water**][**polymer admixture**] to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists negative-side hydrostatic pressure, and has properties complying with or exceeding the criteria specified below.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anti-Hydro International, Inc**]
    b. [**AQUAFIN, Inc**]
    c. [**ChemMasters, Inc**]
    d. [**EDCO Products Inc.**]
    e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    f. [**Five Star Products, Inc.**]
    g. [**Gemite Products Inc., a W.R. Meadows company**]
    h. [**International Chem-Crete, Inc.**]
    i. [**Master Builders Solutions**]
    j. [**Metalcrete Industries**]
    k. [**Sakrete; CRH Americas, Oldcastle APG**]
    l. [**Sika Corporation**]
    m. [**SpecChem, LLC**]
    n. [**Specco Industries, Inc**]
    o. [**United Gilsonite Laboratories (UGL)**]

2. Water Permeability: Maximum [**zero for water at 30 ft. (9 m)**] when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum [**4000 psi (27.6 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

4. Flexural Strength: Minimum [**710 psi (4.8 MPa)**] at 28 days when tested in accordance with ASTM C348.
5. Potable Water Containment: Products of this Section must be certified to NSF 61 for use with potable water.
6. Color: [**White**][**Gray**][**Match Architect's samples**][**As selected by Architect from full range**][**As indicated in a color schedule**], as directed by the Owner.
7. VOC Content: [**100**] g/L or less.
8. Low-Emitting Materials: Verify interior coatings comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. VOC Content: [**100**] g/L or less.
10. Low-Emitting Materials: Verify VOC emissions of interior coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
11. VOC Emissions: Verify interior coatings contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Positive-Side, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with [**water**][**polymer admixture**] to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists positive-side hydrostatic pressure, and has properties complying with or exceeding the criteria specified below.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anti-Hydro International, Inc**]
    b. [**AQUAFIN, Inc**]
    c. [**Conproco Corporation**]
    d. [**Damtite Waterproofing, Inc.**]
    e. [**EDCO Products Inc.**]
    f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    g. [**Five Star Products, Inc.**]
    h. [**Gemite Products Inc., a W.R. Meadows company**]
    i. [**International Chem-Crete, Inc.**]
    j. [**Master Builders Solutions**]
    k. [**Metalcrete Industries**]
    l. [**Sakrete; CRH Americas, Oldcastle APG**]
    m. [**Sika Corporation**]
    n. [**SpecChem, LLC**]
    o. [**Specco Industries, Inc**]
    p. [**United Gilsonite Laboratories (UGL)**]
    q. [**Wall Firma, Inc**]

2. Water Permeability: Maximum [**zero for water at 30 ft. (9 m)**] when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum [**4000 psi (27.6 MPa)**] at 28 days when tested in accordance

with ASTM C109/C109M.

4. Flexural Strength: Minimum [**710 psi (4.8 MPa)**] at 28 days when tested in accordance with ASTM C348.
5. Color: [**White**][**Gray**][**Match Architect's samples**][**As selected by Architect from full range**][**As indicated in a color schedule**], as directed by the Owner.

2.2 FIELD-MIXED, POLYMER-MODIFIED CEMENT WATERPROOFING

A. Admixture for Field Mixing: Manufacturer's standard polymer admixture for mixing with portland cement and sand to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists [**positive**][**negative**]-side hydrostatic pressure and has properties complying with or exceeding the criteria specified below.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anti-Hydro International, Inc**]
    b. [**United Gilsonite Laboratories (UGL)**]

2. Water Permeability: Maximum [**zero for water at 30 ft. (9 m)**] when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum [**4000 psi (27.6 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.
4. Flexural Strength: Minimum [**710 psi (4.8 MPa)**] at 28 days when tested in accordance with ASTM C348.
5. VOC Content: [**100**] g/L or less.
6. Low-Emitting Materials: Verify interior coatings comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. VOC Content: [**100**] g/L or less.
8. Low-Emitting Materials: Verify VOC emissions of interior coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. VOC Emissions: Verify interior coatings contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.3 ACCESSORY MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use.

B. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended in writing by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections, and compatible with substrate and other materials indicated.

C. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and

recommended in writing by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.

D. Portland Cement: ASTM C150/C150M, Type I.

E. Slurry-Coat Sand: ASTM C144.

F. Trowel-Coat Sand: ASTM C33/C33M, fine aggregate.

G. Water: Potable.

2.4 MIXES

A. Prepackaged, Polymer-Modified Cement Waterproofing: Add prepackaged dry ingredients to mixing liquid in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.

B. Field-Mixed, Polymer-Modified Cement Waterproofing: Add polymer admixture to portland cement and sand in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.

B. Confirm water stops and other primary joint seals have been installed in concrete joints.

C. Confirm waterproofing thickness to be applied to substrate face locations will not interfere with required operating and service clearances for elevators and other equipment to be installed within pits.

D. Proceed with application only after unsatisfactory conditions have been corrected.

E. Notify the Owner in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

A. Comply with manufacturer's written instructions.

B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure[**to confine spraying operation and**] to ensure adequate ambient temperatures and ventilation conditions for application.

C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

D. Stop active water leaks with plugging compound.

E. Repair damaged or unsatisfactory substrate with patching compound.

1. At holes and cracks **1/16 inch (1.6 mm)** wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum **1 inch (25 mm)** deep. Fill reveal with patching compound flush with surface.

F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces in accordance with ASTM D4258.

a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution in accordance with ASTM D4260.
b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning in accordance with ASTM D4259.

2. Clean concrete unit masonry surfaces in accordance with ASTM D4261.

a. Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
b. Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of **1/16 inch (1.6 mm)**.

3. Clean clay masonry surfaces in accordance with ASTM D5703.
4. Concrete Joints: Clean reveals.

3.3 APPLICATION OF POLYMER-MODIFIED CEMENT WATERPROOFING

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water[**for several hours**] and maintain damp condition until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:

a. Onto columns integral with treated walls.
b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of [**24 inches (600 mm) for cast-in-place concrete**][**48 inches (1200 mm) for masonry**].
c. Onto exterior walls and onto both exterior and interior columns, for a height of **12 inches (300 mm)**, where floors, but not walls, are treated.
d. Onto every substrate in areas indicated for treatment, including [**pipe trenches**][**pipe chases**][**pits**][**sumps**][**similar offsets and features**].

3. Number of Coats: [**Number required for specified water permeability**][**Two**][**Three**].

a. Coating Thickness: Maximum application thickness of [**47 mils (1.2 mm)**][**60 mils (1.5 mm)**] per coat for total thickness [**as required for specified water permeability**][**of 100 mils (2.5 mm)**][**of 120 mils (3.0 mm)**].
b. Apply first coat as a slurry with brush or roller, and apply subsequent coats with brush, roller, spray, or trowel.
c. Vigorously work first coat onto the substrate, forcing the material into surface voids. Apply each subsequent coat into full contact with previous coat.
d. Allow manufacturer's recommended time between coats. Dampen surface between coats.

B. Final Coat Finish: [**Smooth troweled**][**Brushed**][**Textured**].

C. Curing:

1. Air-cure waterproofing for not less than [**five**] days immediately after application and prior to being placed in service.
2. Moist-cure waterproofing for not less than [**three**] days immediately after application has set, followed by air drying prior to being placed in service unless otherwise recommended in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed application of waterproofing.

B. Prepare test and inspection reports.

3.5 PROTECTION AND CLEANING

A. Protect surfaces from hot, dry, and windy weather conditions. Prevent rapid drying through manufacturer-approved methods.

END OF SECTION 07 16 13 00

SECTION 07 16 16 00 - CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Crystalline waterproofing.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete slabs serving as protective topping for waterproofing and the finishing of concrete walls and slabs to receive waterproofing.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemically Compatible: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength, complying with specified performance requirements when in contact with another material.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation Work, including other waterproofing systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements including, but not limited to, the following:

a. Minimum concrete curing period.
b. Forecasted weather conditions.
c. Repairs.
d. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and installation instructions.

B. Sustainable Design Submittals:

1. Product Data: For waterproofing, providing information for testing in compliance with ASHRAE 160-2016.2009.
2. Product Data: For waterproofing, providing information for testing in compliance with CCR, Title 24, Part 2, Section 1202 and Ch. 14.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statement: For [**Applicator**][**testing agency**].

B. Product Test Reports: For each product formulation, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Field quality-control reports.

D. Sample warranties.

1.7 QUALITY ASSURANCE

A. Applicator Qualifications: Entity that employs applicators and supervisors who are trained[**and approved**] by waterproofing manufacturer in applying crystalline waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.8 MOCKUPS

A. Build mockups to set quality standards for materials and execution.

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged waterproofing materials in original undamaged containers, with manufacturer's labels and seals intact.

B. Store materials in dry environment at a temperature above **45 degrees F (7 degrees C)**.

C. Do not use materials stored for more than 24 months from date of manufacture.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be applied in accordance with manufacturer's written instructions and warranty requirements.

B. Proceed with waterproofing work only after installation of pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

1.11 WARRANTY

A. Manufacturer's Material Warranty: Manufacturer agrees to replace waterproofing that fails to remain watertight within specified warranty period.

1. Warranty includes replacement of waterproofing system.
2. Warranty Period: [**Five**][**Ten**] years from date of Substantial Completion.

B. Applicator's Special Warranty: Submit warranty signed by Applicator, to replace waterproofing that fails to remain watertight within specified warranty period covering Work of this Section.

1. Warranty includes leak remediation, and coverage for failure to meet specified requirements, including defects caused by faulty workmanship.
2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WATERPROOFING MATERIALS

A. Crystalline Waterproofing: Prepackaged, [**gray**][**white**]-colored proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into concrete and concrete unit masonry and reacts chemically with the byproducts of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate; with properties complying with or exceeding the criteria specified below.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**AQUAFIN, Inc**]
c. [**ChemMasters, Inc**]
d. [**Conproco Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Gemite Products Inc., a W.R. Meadows company**]
g. [**International Chem-Crete, Inc.**]
h. [**IPA Systems, Inc.**]
i. [**KOSTER American Corporation**]
j. [**Kryton International, Inc.**]
k. [**Master Builders Solutions**]

l. [**Penetron USA, Inc.**]
m. [**Sika Corporation**]
n. [**Tremco Incorporated**]
o. [**Xypex Chemical Corporation**]

2. Water Permeability: Maximum [**zero for water at 30 ft. (9 m)**] when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum [**4000 psi (27.6 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.
4. Self-Sealing: Autogenous crack sealing of treated concrete for cracks with width of **0.02 inch (0.5 mm)** or greater when subjected to hydrostatic pressure of **65 psi (0.44 MPa)**.
5. Sulfate Resistance: The waterproofing treatment must improve concrete resistance to sulfates by reducing permeability without affecting compressive strength; performance to be verified by independent testing.
6. Potable Water Containment: Products of this Section must be certified to NSF 61 for use with potable water.

2.2 ACCESSORY MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use.

B. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended in writing by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; and compatible with substrate and other materials indicated.

C. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended in writing by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.

D. Water: Potable.

2.3 MIXES

A. Crystalline Waterproofing: Add prepackaged dry ingredients to water in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.

B. Proceed with application only after unsatisfactory conditions have been corrected.

C. Notify Architect in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

A. Comply with manufacturer's written instructions.

B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure[**to confine spraying operation and**] to ensure adequate ambient temperatures and ventilation conditions for application.

C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

D. Stop active water leaks with plugging compound.

E. Repair damaged or unsatisfactory substrate with patching compound.

1. At holes and cracks **1/16 inch (1.6 mm)** wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum **1 inch (25 mm)** deep. Fill reveal with patching compound flush with surface.

F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces in accordance with ASTM D4258.

a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution in accordance with ASTM D4260.
b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning in accordance with ASTM D4259.

2. Clean concrete unit masonry surfaces in accordance with ASTM D4261.

a. Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
b. Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of **1/16 inch (1.6 mm)**.

3. Concrete Joints: Clean reveals.

3.3 APPLICATION OF CRYSTALLINE WATERPROOFING

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water for several hours and maintain damp condition until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:

a. Onto columns integral with treated walls.
b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of [**24 inches (600 mm) for cast-in-place concrete**][**48 inches (1200 mm) for masonry**].
c. Onto exterior walls and onto both exterior and interior columns, for a height of **12 inches (300 mm)**, where floors, but not walls, are treated.
d. Onto every substrate in areas indicated for treatment, including [**pipe trenches**][**pipe chases**][**pits**][**sumps**][**similar offsets and features**].

3. Number of Coats: [**Number required for specified water permeability**][**Two**][**Three**].
4. Application Method: Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.
5. Dampen surface between coats.

B. Final Coat Finish: [**Smooth**][**Brushed**][**Spray textured**].

C. Curing: Moist-cure waterproofing for [**three**] days immediately after final coat has set, followed by air drying, unless otherwise recommended in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed application of waterproofing.

B. Prepare test and inspection reports.

END OF SECTION 07 16 16 00

SECTION 07 16 19 00 - METAL OXIDE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-oxide waterproofing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for forms and waterstops.
2. Section 033000 "Cast-in-Place Concrete" for concrete slabs serving as protective topping for waterproofing and the finishing of concrete walls and slabs to receive waterproofing.
3. Section 042000 "Unit Masonry" for cleaning of unit masonry walls to receive waterproofing.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.2 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill [**other waterproofing systems**] [**underslab vapor retarders**] [**underslab insulation**] [**subdrainage systems**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements including, but not limited to, the following:

a. Minimum concrete curing period.
b. Forecasted weather conditions.
c. Repairs.
d. Field quality control.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and installation instructions.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Applicator [**and testing agency**].

B. Manufacturer Certificates: For each type of waterproofing, patching, and plugging material.

C. Product Test Reports: For tests performed by manufacturer and witnessed by a qualified testing agency.

1. Iron content of metallic waterproofing.
2. Oxidizing agent content of metallic waterproofing.

D. Field quality control reports.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: A firm that employs applicators and supervisors who are trained and [**certified**] [**approved**] by waterproofing manufacturer.

1.7 MOCKUPS

A. Build mockups to verify selections made under submittals and to set quality standards for application.

1. Build mockup of typical [**vertical**] [**horizontal**] surfaces [**as shown on Drawings**].

a. Size: [**100 sq. ft. (9.29 sq. m) in size**].

2. Visually and physically examined for bonding and loose materials by waterproofing material manufacturer.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged waterproofing materials in original undamaged containers, with manufacturer's labels and seals intact.

B. Store in dry locations, at the temperature recommended in writing by the manufacturer, with adequate ventilation and handle in a manner to prevent damage or contamination.

C. Remove and replace materials that cannot be applied within their stated shelf life.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit metal-oxide waterproofing to be performed in accordance with manufacturer's written instructions and warranty requirements.

B. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

C. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

PART 2 - PRODUCTS

2.1 WATERPROOFING MATERIALS

A. Metal-Oxide Waterproofing: A product specifically formulated for waterproofing concrete and masonry substrates and containing pulverized iron and a chemical oxidizing agent to cause the iron particles to oxidize and grow in size in the presence of water.

2.2 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by metal-oxide waterproofing manufacturer for intended use and compatibility with one another and with waterproofing.

B. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended in writing by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; and compatible with substrate and other materials indicated.

C. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended in writing by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.

D. Portland Cement: ASTM C150/C150M, Type I.

E. Sand: ASTM C144.

F. Aggregate for Protective Coat: ASTM C33/33M.

G. Water: Potable.

H. Sealant: Polyurethane foam.

2.3 MIXES

A. Metal-Oxide Coats: Add metal-oxide waterproofing compound and other mix components, if any, to water in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency for each coat.

B. Measure, batch, and mix portland cement and sand in the proportion of [**1:2-1/2**] and water. Blend together with mechanical mixer to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.

B. Confirm water stops and other primary joint seals have been installed in concrete joints.

C. Proceed with application only after unsatisfactory conditions have been corrected.

D. Notify Architect in writing of active leaks or defects that would affect system performance, as directed by the Owner.

E. Confirm waterproofing thickness to be applied to substrate face locations will not interfere with required operating and service clearances for elevators and other equipment installed within pits.

3.2 PREPARATION

A. Comply with manufacturer's written instructions.

B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to ensure adequate ambient temperatures and ventilation conditions for application.

C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

D. Stop active water leaks with plugging compound.

E. Repair damaged or unsatisfactory substrate with patching compound.

1. At holes and cracks 1/16 inch (1.6 mm) wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum 1 inch (25 mm) deep. Fill reveal with patching compound flush with surface.

F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces in accordance with ASTM D4258.

    a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution in accordance with ASTM D4260.
    b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning in accordance with ASTM D4259.

2. Clean concrete unit masonry surfaces in accordance with ASTM D4261.

    a. Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
    b. Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).

3. Clean clay masonry surfaces in accordance with ASTM D5703.
4. Concrete Joints: Clean reveals.

3.3 APPLICATION OF METAL-OXIDE WATERPROOFING

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water and maintain damp condition in accordance with manufacturer's written instructions until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:

    a. Onto columns integral with treated walls.
    b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of [**24 inches (600 mm) for cast-in-place concrete**] [**48 inches (1200 mm) for masonry**].
    c. Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches (300 mm), where floors, but not walls, are treated.
    d. Onto every substrate in areas indicated for treatment, including [**pipe trenches**] [**pipe chases**] [**pits**] [**sumps**] [**and similar offsets and features**].

3. Number of Metal-Oxide Coats: Applying two or more coats required for specified water permeability.
4. Application Method: Brush apply the waterproofing, vigorously working first coat onto the substrate and forcing the material into surface voids. Brush each subsequent coat into full contact with previous coat.
5. Dampen surface between coats.
6. Allow each coat to set for maximum 24 hours between coats.

B. Wall and Columns Protection Coat: Immediately after metal-oxide coats have set, apply protection coat on walls and columns to a minimum thickness of [**1/8 inch (3 mm)**].

1. Finish: [**Smooth**] [**Brushed**] [**Textured**].

C. Floors Protective Topping: Immediately after metal-oxide coats have set, apply floor topping to a thickness of [**1 inch (25 mm)**] [**1-1/2 inches (38 mm)**].

1. Finish: [**Smooth**] [**Brushed**].

D. Curing: Moist-cure waterproofing for [**three**] days immediately after installation has set, followed by air drying prior to being placed in service, unless otherwise recommended in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed application of waterproofing.

B. Prepare test and inspection reports.

END OF SECTION 07 16 19 00

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SECTION 07 17 00 00 - BENTONITE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Geotextile/bentonite sheets.
2. Composite bentonite membrane.
3. Protection course.
4. Molded-sheet drainage panels.
5. Insulation drainage panels.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for forms and waterstops.
2. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
4. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.
5. Section 312000 "Earth Moving" for excavating and backfilling.
6. Section 315000 "Excavation Support and Protection" for permanent below-grade support systems that receive blindside waterproofing.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemical Compatibility: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

1.3 COORDINATION

A. Coordinate the Work of this Section with adjacent concrete foundation work, including fill[**, other waterproofing systems**] [**, under-slab vapor retarders**] [**, under-slab insulation**] [**and**] [**subdrainage systems**].

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations through waterproofing.

C. Coordinate formwork and form bracing requirements for blindside sheet waterproofing. Coordinate restrictions on use of form ties and other components as necessary to eliminate or minimize penetrations through blindside sheet waterproofing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.5 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
b. Include manufacturer's written installation instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, air barrier, and other termination conditions.

C. Samples: For each of the following products, in sizes indicated:

1. Waterproofing: 6 inches (150 mm) square.
2. Protection Course: 6 inches (150 mm) square.
3. Molded-Sheet Drainage Panels: 6 inches (150 mm) square.
4. Insulation Drainage Panels: 6 inches (150 mm) square.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates: For each type of waterproofing material.

B. Preconstruction Test Reports: For water samples taken at Project site along with recommendations resulting from these tests.

C. Field quality control reports.

D. Sample warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that employs installers and supervisors who are trained and [**certified**] [**approved**] by waterproofing manufacturer.

1.8 MOCKUPS

A. Build mockups to verify selections made under samples and set quality standards for application.

1. Build mockup of installation on typical [**vertical**] [**and**] [**horizontal**] surfaces [**as indicated on Drawings**].

a. Size: [**10 sq. ft. (0.9 sq. m) in size**].

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in factory-sealed and -labeled packaging. Handle and store following manufacturer's instructions, recommendations, and material safety data sheets. Protect from construction operation-related damage and damage from weather, excessive temperatures, and prolonged sunlight.

B. Do not double-stack pallets during shipping or storage. Protect waterproofing materials from moisture, excessive temperatures, and sources of ignition. Provide cover, top, and all sides, for materials stored on-site, allowing for adequate ventilation.

C. Remove damaged material from site and dispose of in accordance with applicable regulations.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing on ground water.

1. Obtain water samples from Project site at approximate locations where waterproofing will be installed and test for acids, alkalis, brine, or other contaminants that may inhibit performance of waterproofing materials.
2. Comply with waterproofing manufacturer's written instructions for testing.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterproofing to be installed in accordance with manufacturer's written instructions and warranty requirements.

1. Do not apply waterproofing materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.
2. Do not place bentonite clay products in panel or composite form on damp surfaces unless such practice is approved in writing by manufacturer.

1.12 WARRANTY

A. Special Warranty: Manufacturer [**and Installer**] agree(s) to repair or replace components of bentonite waterproofing system that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**] [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain bentonite waterproofing system from single source from single manufacturer. Obtain accessory products used with bentonite waterproofing, including waterstops specified in Section 033000 "Cast-in-Place Concrete" from sources acceptable to bentonite waterproofing manufacturer.

2.2 GEOTEXTILE/BENTONITE SHEETS

A. Geotextile/Bentonite Sheet: Minimum of 1.10 lb/sq. ft. (5.37 kg/sq. m) of granular sodium bentonite between two layers of polypropylene geotextile fabric, one woven and one nonwoven, needle punched.

1. Grab Tensile Strength: [**95 lbf (422 N)**] in accordance with ASTM D4632.
2. Puncture Resistance: 100 lbf (445 N) in accordance with ASTM D4833.

B. Contaminant-Resistant Geotextile/Bentonite Sheet: Minimum of 1.10 lb/sq. ft. (5.37 kg/sq. m) of contaminant-resistant granular sodium bentonite, specially formulated for use in saltwater or contaminated ground water, between two layers of polypropylene geotextile fabric, one woven and one nonwoven, needle punched.

1. Grab Tensile Strength: [**95 lbf (422 N)**] in accordance with ASTM D4632.
2. Puncture Resistance: 100 lbf (445 N) in accordance with ASTM D4833.

C. Polyethylene-Lined Geotextile/Bentonite Sheet: Minimum of 1.0 lb/sq. ft. (4.8 kg/sq. m) of granular sodium bentonite between two layers of geotextile fabric.

1. Grab Tensile Strength: 95 lbf (422 N) in accordance with ASTM D4632.
2. Puncture Resistance: 100 lbf (445 N) in accordance with ASTM D4833.
3. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

D. Contaminant-Resistant Polyethylene-Lined Geotextile/Bentonite Sheet: Minimum of 1.0 lb/sq. ft. (4.8 kg/sq. m) of contaminant-resistant granular sodium bentonite clay granules, specially formulated for use in saltwater or contaminated ground water, between two layers of geotextile fabric.

1. Grab Tensile Strength: 120 lbf (530 N) in accordance with ASTM D4632.
2. Puncture Resistance: 140 lbf (620 N) in accordance with ASTM D4833.
3. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

2.3 COMPOSITE BENTONITE MEMBRANE

A. Composite Bentonite Membrane: Manufacturer's standard membrane consisting of a geomembrane liner bonded to a layer of bentonite.

1. Puncture Resistance: 155 lbf (689 N) in accordance with ASTM E154.
2. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

B. Composite Bentonite Membrane with Protective Facing: Manufacturer's standard membrane consisting of geomembrane liner bonded to a layer of bentonite clay granules with a spun polypropylene facing.

1. Puncture Resistance: 155 lbf (689 N) in accordance with ASTM E154.

2. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

C. Contaminant-Resistant Composite Bentonite Membrane: Manufacturer's standard membrane consisting of polyethylene geomembrane bonded to a layer of bentonite.

1. Puncture Resistance: 112 lbf (498 N) in accordance with ASTM E154.
2. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

2.4 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by bentonite waterproofing manufacturer for intended use and compatibility with one another and with waterproofing.

B. Granular Bentonite: Sodium bentonite clay containing a minimum of 90 percent montmorillonite (hydrated aluminum silicate), with a minimum of 90 percent passing a No. 20 (0.85 mm) sieve.

C. Bentonite Mastic: Bentonite compound of trowelable consistency, specifically formulated for application at joints and penetrations.

D. Bentonite Tubes: Manufacturer's standard 2-inch- (50-mm-) diameter, water-soluble tube containing approximately 1.5 lb/ft. (2.2 kg/m) of granular bentonite; hermetically sealed; designed specifically for placing on wall footings at line of joint with exterior base of wall.

E. Metal Termination Bars: Manufacturer's standard aluminum or stainless steel bars with upper flange to receive sealant.

F. Plastic Protection Sheet: Polyethylene sheeting in accordance with ASTM D4397; thickness as recommended in writing by waterproofing manufacturer to suit application but at least 6 mils (0.15 mm) thick.

G. Cement Grout Patching Material: Grout mix compatible with substrate being patched and recommended in writing by waterproofing manufacturer.

H. Masonry Fasteners: Case-hardened nails or hardened-steel, powder-actuated fasteners. Depending on manufacturer's written requirements, provide 1/2- or 1-inch- (13- or 25-mm-) diameter washers under fastener heads.

I. Sealants: As recommended in writing by waterproofing manufacturer. Comply with requirements specified in Section 079200 "Joint Sealants."

J. Tapes: Waterproofing manufacturer's recommended waterproof tape for joints between sheets, membranes, or panels.

K. Adhesive: Waterproofing manufacturer's water-based adhesive used to secure waterproofing to both vertical and horizontal surfaces.

2.5 PROTECTION COURSE

A. Protection course material of type and thickness as recommended in writing by waterproofing manufacturer for each Project condition.

2.6 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel acceptable to dampproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core, with or without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

2.7 INSULATION DRAINAGE PANELS

A. Insulation Drainage Panels:

1. Comply with Section 072100 "Thermal Insulation" for insulation drainage panels.
2. Unfaced or geotextile-faced, extruded-polystyrene board insulation in accordance with ASTM C578, Type IV, 25 psi (173 kPa), or Type VI, 40 psi (276 kPa), minimum compressive strength; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations and other conditions affecting performance of bentonite waterproofing.

B. Examine bentonite materials before installation. Reject materials that have been prematurely exposed to moisture.

C. Verify that substrate is complete and that work that will penetrate waterproofing is complete and rigidly installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with manufacturer's written instructions.

B. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with bentonite mastic or cement grout patching material in accordance with manufacturer's written instructions.

C. Horizontal Concrete Surfaces: Remove debris, standing water, oily substances, mud, and similar substances that could impair the bonding ability of concrete or the effectiveness of waterproofing. Fill voids, cracks greater than 1/8 inch (3 mm), honeycomb areas, and other defects with bentonite mastic or cement grout patching material in accordance with manufacturer's written instructions.

D. Excavation Support and Protection System: If water is seeping, use plastic protection sheets or other suitable means to prevent wetting the bentonite waterproofing. Fill minor gaps and spaces 1/8 inch

(3 mm) wide or wider with wood, metal, concrete, or other appropriate filling material. Cover or fill large voids and crevices with cement mortar in accordance with manufacturer's written instructions.

3.3 INSTALLATION, GENERAL

A. Prepare substrates, voids, cracks, and cavities; and install waterproofing and accessories in accordance with manufacturer's written instructions.

1. Before installing, verify the correct side of waterproofing that faces substrate surface.
2. Apply granular bentonite around penetrations in horizontal surfaces and changes in plane in accordance with manufacturer's details in preparation for bentonite tubes and mastic.
3. Apply bentonite tubes, bentonite mastic, or both at changes of plane, construction joints in substrate, projections, and penetrations.
4. Prime concrete substrates. Primer may be omitted on concrete surfaces that comply with manufacturer's written requirements for dryness, surface texture, and freedom from imperfections.

B. Apply bentonite tubes continuously on footing against base of wall to be waterproofed.

C. Protect waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts.

D. Install protection course before backfilling or placing overburden when recommended in writing by waterproofing manufacturer.

3.4 INSTALLATION OF GEOTEXTILE/BENTONITE SHEETS

A. Install a continuous layer of waterproofing sheets directly against surface to be waterproofed. Lap ends and edges a minimum of 4 inches (100 mm) on horizontal and vertical substrates unless otherwise indicated. Stagger end joints between sheets a minimum of 24 inches (600 mm). Fasten seams by stapling to adjacent sheet or nailing to substrate.

B. Below Structural Slabs-on-Grade: Place waterproofing sheets on compacted substrate with ends and edges lapped and stapled.

1. Install a layer of waterproofing sheets under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.

C. Concrete Walls: Starting at bottom of wall, apply waterproofing sheets horizontally against wall. Secure with masonry fasteners spaced in accordance with manufacturer's written instructions. Extend to bottom of footing, grade beam, or wall, and secure.

D. Termination at Grade:

1. Extend waterproofing sheets to within [**12 inches (300 mm)**] of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
2. Fasten top edge of waterproofing sheets to wall and protect top edge with sheet metal counterflashing. Cover waterproofing with a lapped course of plastic protection sheets if backfilling does not proceed immediately.

E. Excavation Support and Protection (Permanent Shoring): Encase tieback heads, rods, nuts, and plates in accordance with waterproofing manufacturer's written instructions for each configuration.

1. Install a layer of waterproofing sheets, with ends and edges lapped and nailed to shoring. Cover waterproofing with plastic protection sheets if needed for protection from precipitation; remove plastic sheets before placing concrete.
2. Inspect and repair waterproofing after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

3.5 INSTALLATION OF COMPOSITE BENTONITE MEMBRANE

A. Install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 4 inches (100 mm) unless otherwise indicated. Stagger end joints between membranes a minimum of 24 inches (600 mm). Seal joints with permanent seam tape or heat-welded for gas barrier.

B. Below Structural Slabs-on-Grade: Apply waterproofing membrane with polyethylene side down, and staple ends and edges.

1. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.
2. Protect waterproofing from damage caused by reinforcing bar supports with sharp edges.

C. Slabs: Starting at lowest point, install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 4 inches (100 mm).

D. Concrete Walls: Apply mastic to form continuous 3/4-inch (19-mm) cant or fillet at intersection of footings and walls.

1. Starting at lowest point, install a layer of waterproofing membrane horizontally, extending a minimum of 6 inches (150 mm) onto the footing. Lap membrane ends and edges a minimum of 2 inches (50 mm).
2. Secure membrane to wall.
3. Apply mastic to form continuous 3/4-inch (19-mm) layer around penetrations.
4. Termination at Grade: Extend waterproofing membrane to within [**12 inches (300 mm)**] of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.

E. Excavation Support and Protection (Permanent Shoring): Cut, clean, and treat tiebacks and similar projections. Encase tieback heads, rods, nuts, and plates in accordance with waterproofing manufacturer's written instructions for each configuration. If water is present, cover shoring and lagging with plastic protection sheets; remove plastic sheets before placing concrete.

1. Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped minimum of 4 inches (100 mm) and nailed to shoring.
2. Inspect and repair waterproofing membrane after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

F. Horizontal Roofs, Plazas, and between Slabs: Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped a minimum of 3 inches (75 mm).

1. Apply mastic to form continuous 3/4-inch (19-mm) cant or fillet at intersection of horizontal and vertical substrates. Extend waterproofing membrane to top of curb or to a minimum of 6 inches (150 mm) above plane of waterproofing; secure with manufacturer's recommended tape.
2. Clean overlap area and apply waterproof tape, rolling the exposed edge to seal to membrane below.
3. Turn edges up and seal to vertical surfaces.

3.6 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels in accordance with manufacturer's written instructions. Use adhesives or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install protection course before installing drainage panels.

3.7 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation units in adhesive or tape applied in accordance with manufacturer's written instructions.

D. On horizontal surfaces, loosely lay insulation drainage panels in accordance with manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:

1. Engage a factory-authorized service representative to test and inspect completed waterproofing installation before covering with other construction and provide written report stating that installation complies with manufacturer's written instructions.

a. Remove and replace applications of bentonite waterproofing where inspection indicates that it does not comply with specified requirements.

2. Engage a [**full-time**] site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect, as directed by the Owner.

B. Waterproofing will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 PROTECTION, REPAIR, AND CLEANING

A. Do not permit traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Correct deficiencies in waterproofing or remove waterproofing that does not comply with requirements; repair substrates and reapply waterproofing.

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Task	Specification	Specification Description
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SECTION 07 18 00 00 - TRAFFIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Traffic coatings and pavement markings for the following applications:

1. Pedestrian traffic.
2. Vehicular traffic.
3. Equipment-room floor.

B. Related Requirements:

1. Section 071900 "Water Repellents" for penetrating and film-forming water repellents applied on traffic-bearing surfaces.
2. Section 096723 "Resinous Flooring" for fluid-applied, [**decorative**][**general-use commercial**][**general-use industrial**][**high-performance**] resinous flooring that does not serve as a waterproofing membrane with integral wearing surface.
3. Section 096766 "Fluid-Applied Athletic Flooring" for fluid-applied, resinous flooring for athletic activity areas.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: Traffic coatings and pavement markings for the following applications:

1. Pedestrian traffic.
2. Vehicular traffic.
3. Equipment-room floor.

B. Product Data Submittals: For each product.

1. Include installation instructions and details, material descriptions, dry- or wet-film thickness requirements, and finish.

C. Sustainable Design Submittals:

1. Product Data: For coatings, indicating VOC content.
2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
3. Product Test Reports: For traffic coatings, documentation indicating the Solar Reflectance properties.

D. Shop Drawings: For traffic coatings.

1. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other

termination conditions that are not included in manufacturer's product data.

2. Include plans showing layout of pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

E. Samples for Initial Selection: For each type of exposed finish.

F. Samples for Verification: For each type of exposed finish, prepared on rigid backing.

1. Provide stepped Samples on backing to illustrate buildup of traffic coatings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of traffic coating.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For traffic coatings to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to set quality standards for materials and execution.

1. Build mockup for each traffic coating and substrate to receive traffic coatings.
2. Size: [**200 sq. ft. (18.5 sq. m)**] of each substrate to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below **40 deg F (5 deg C)**, when relative humidity exceeds 85 percent, or when temperatures are less than **5 deg F (3 deg C)** above dew point.

1. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.

B. Do not install traffic coating until items that penetrate membrane have been installed.

C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of [**40 deg F (4.4 deg C) for oil-based materials**][**50 deg F (10 deg C) for water-based materials**], and not exceeding **95 deg F (35 deg C)**.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace traffic coating that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Adhesive or cohesive failures.
b. Abrasion or tearing failures.
c. Surface crazing or spalling.
d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain traffic coatings from single source from single manufacturer.

B. Obtain primary traffic-coating materials, including primers, from traffic-coating manufacturer. Obtain accessory materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of types and from sources recommended in writing by primary material manufacturer.

C. Obtain pavement-marking paint from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Material Compatibility: Provide primers; base coat, intermediate coat, and topcoat; and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.3 TRAFFIC COATINGS

A. Traffic Coating : Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, water-resistant membrane system with integral wearing surface for [**pedestrian traffic**][**vehicular traffic**][**equipment-room floor**] service condition; according to ASTM C957/C957M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Polymer Technology Corp.**]
b. [**Crossfield Products Corp**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Gaco; Holcim Building Envelope**]
e. [**GCP Applied Technologies Inc.**]
f. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
g. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
h. [**Insl-X Products; Benjamin Moore & Co.**]
i. [**Key Resin Company**]
j. [**LymTal International, Inc.**]
k. [**Master Builders Solutions**]
l. [**Neogard; Hempel Group**]
m. [**Pacific Polymers; a Holcim brand**]
n. [**Pecora Corporation**]
o. [**POLY-CARB; Olin Corporation**]
p. [**Polycoat Products**]
q. [**PPG Paints; PPG Industries, Inc.**]
r. [**Sherwin-Williams Company (The)**]
s. [**Soprema, Inc.**]
t. [**Tremco Incorporated**]
u. [**Urethane Polymers International, Inc. (UPI)**]

B. Primer: Liquid primer as recommended in writing for substrate and conditions by traffic-coating manufacturer.

1. Material: [**Epoxy**][**Polyurethane**].

C. Preparatory and Base Coats: [**Polyurethane**][**Aromatic urethane**][**Aliphatic urethane**][**epoxy**].

1. Thicknesses: Minimum [**dry-**][**wet-**]film thickness [**as recommended in writing by manufacturer for substrate and service conditions indicated**].

D. Intermediate Coat: [**Polyurethane**][**Aromatic urethane**][**Aliphatic urethane**][**epoxy**].

1. Thicknesses: Minimum [**dry-**][**wet-**]film thickness [**as recommended in writing by manufacturer for substrate and service conditions indicated**], measured excluding aggregate.
2. Aggregate Content: [**As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated**][**Not less than 8 to 10 lb/100 sq. ft. (3.9 to 4.9 kg/10 sq. m)**][**To refusal**].

E. Topcoat: [**Polyurethane**][**Aromatic urethane**][**Aliphatic urethane**][**Aromatic urethane with UV inhibitors**][**epoxy**].

1. Thicknesses: Minimum [**dry-**][**wet-**]film thickness [**as recommended in writing by manufacturer for substrate and service conditions indicated**], measured excluding aggregate.
2. Aggregate Content: [**As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated**][**As required to achieve slip-resistant finish**][**8 to 10 lb/100 sq. ft. (3.9 to 4.9 kg/10 sq. m)**][**To refusal**].
3. Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's sample**].

F. Aggregate: [**Manufacturer's standard aggregate for each use indicated**][**Uniformly graded, washed silicon carbide sand**][**Uniformly graded, washed silica sand**][**Uniformly graded, washed flint shot silica**][**Walnut shell granules**][**Aluminum-oxide grit**] of particle sizes, shape, and minimum hardness

recommended in writing by traffic-coating manufacturer.

G. Fire-Test-Response Characteristics: Provide traffic-coating materials with the fire-test-response characteristics as determined by testing identical products according to test method below for deck type and slopes indicated by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction.

1. [**Class A**][**Class B**][**Class C**] roof covering according to ASTM E108.

H. Energy Star Listing: Provide traffic coating that is listed on the DOE's Energy Star "Roof Products Qualified Product List" for low-slope roof products.

I. Energy Performance: Provide traffic coating with an initial Solar Reflectance Index of [**not less than 0.70**] and emissivity of [**not less than 0.75**] when tested according to CRRC-1.

J. VOC Content, LEED 2009: [**250**] g/L or less.

K. Low-Emitting Materials, LEED 2009: Interior coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

L. VOC Content, LEED v4: [**100**] g/L or less.

M. Low-Emitting Materials, LEED v4: Interior coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

N. VOC Content: [**100**] g/L or less.

O. Low-Emitting Materials: VOC emissions of interior coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

P. VOC Content: [**100**] g/L or less.

Q. Low-Emitting Materials: Interior coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

R. VOC Emissions: Interior coatings shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.4 ACCESSORY MATERIALS

A. Joint Sealants: [**As specified in Section 079200 "Joint Sealants."**][**ASTM C920.**].

B. Sheet Flashing: Nonstaining [**sheet material recommended in writing by traffic-coating**

manufacturer][**uncured neoprene sheet**][**cured neoprene sheet**].

1. Thickness: Minimum [**60 mils (1.5 mm)**][**50 mils (1.3 mm)**].

C. Adhesive: Contact adhesive recommended in writing by traffic-coating manufacturer.

D. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic-coating manufacturer.

2.5 PAVEMENT MARKINGS

A. Pavement-Marking Paint Specified Elsewhere: Comply with Section 321723 "Pavement Markings."

B. Pavement-Marking Paint:

1. Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, [**Type N**][**Type F**][**Type S**]; colors complying with FS TT-P-1952.
2. MPI #32 Alkyd Traffic Marking Paint.
3. Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than [**three**][**45**] minutes.
4. MPI #97 Latex Traffic Marking Paint.
5. Color: [**White**][**Yellow**][**Blue**][**As indicated**].

C. Glass Beads: [**AASHTO M 247, Type 1**][**FS TT-B-1325, Type 1A**].

D. VOC Content: [**150**] g/L or less.

E. Low-Emitting Materials: Interior paints shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. VOC Content: [**100**] g/L or less.

G. Low-Emitting Materials: Interior paints shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. VOC Content: [**100**] g/L or less.

I. Low-Emitting Materials: VOC emissions of interior paints shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

J. VOC Content: [**100**] g/L or less.

K. Low-Emitting Materials: Interior paints shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

L. VOC Emissions: Interior paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor

recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, surface smoothness, and other conditions affecting performance of traffic-coating work.

B. Verify that substrates are visibly dry and free of moisture.

1. Test for moisture according to ASTM D4263.
2. Test for moisture content by [**measuring with an electronic moisture meter**][**method recommended in writing by traffic-coating manufacturer**].

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of traffic-coating work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Begin coating application only after substrate construction and penetrating work have been completed.
2. Begin coating application only after minimum concrete-curing and -drying period recommended in writing by traffic-coating manufacturer has passed and after substrates are dry.
3. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Clean and prepare substrates according to ASTM C1127 and manufacturer's written instructions to produce clean, dust-free, dry substrate for traffic-coating application. Remove projections, fill voids, and seal joints if any, as recommended in writing by traffic-coating manufacturer.

B. Priming: Unless manufacturer recommends in writing against priming, prime substrates according to manufacturer's written instructions.

1. Limit priming to areas that will be covered by traffic-coating material on same day. Reprime areas exposed for more time than recommended by manufacturer.

C. Schedule preparation work so dust and other contaminants from process do not fall on wet, newly coated surfaces.

D. Mask adjoining surfaces not receiving traffic coatings to prevent overspray, spillage, leaking, and migration of coatings. Prevent traffic-coating materials from entering deck substrate penetrations and clogging weep holes and drains.

E. Concrete Substrates: [**Mechanically abrade surface to a uniform profile acceptable to manufacturer, according to ASTM D4259.**]Do not acid etch.

1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
2. Remove concrete fins, ridges, and other projections.
3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release

agents, and other incompatible materials that might affect coating adhesion.

4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D4258.

3.3 TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C1127 and manufacturer's written instructions.

B. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.

C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.

D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D4258.

1. Comply with recommendations in ASTM C1193 for joint-sealant installation.

B. Apply reinforcing strip in traffic-coating system where recommended in writing by traffic-coating manufacturer.

3.5 INSTALLATION OF TRAFFIC COATINGS

A. Apply traffic coating according to ASTM C1127 and manufacturer's written instructions.

B. Apply coats of specified compositions for each type of traffic coating at locations as indicated on Drawings.

C. Start traffic-coating application in presence of manufacturer's technical representative.

D. Verify that wet-film thickness of each coat complies with requirements every [**100 sq. ft.** **(9 sq. m)**].

E. Uniformly broadcast and embed aggregate in each coat indicated to receive aggregate according to manufacturer's written instructions. After coat dries, sweep away excess aggregate.

F. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.

G. Cure traffic coatings. Prevent contamination and damage during coating application and curing.

3.6 INSTALLATION OF PAVEMENT MARKINGS

A. Do not apply pavement-marking paint for striping and other markings until layout, colors, and placement have been verified with Architect and traffic coating has cured.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply pavement-marking paint with mechanical equipment to produce markings of dimensions indicated with uniform straight edges. Apply at manufacturer's recommended rates for a minimum wet-film thickness of **15-mils (0.4-mm)**.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
2. Broadcast glass beads uniformly into wet pavement-marking paint at a rate of **6 lb/gal. (0.72 kg/L)**.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform the following field tests and inspections:

1. Materials Testing:

a. Samples of material delivered to Project site ae to be taken, identified, sealed, and certified in presence of [**the Owner and**]Contractor.
b. Testing agency must perform tests for characteristics specified, using applicable referenced testing procedures.
c. Testing agency must verify thickness of coatings during traffic-coating application for each [**600 sq. ft. (56 sq. m)**] of installed traffic coating or part thereof.

2. Electronic Leak-Detection Testing:

a. Testing agency must test [**each deck area**][**each deck area indicated for testing on Drawings**] for leaks using an electronic leak-detection method that locates discontinuities in the traffic-coating membrane.
b. Testing agency must perform tests on abutting or overlapping smaller areas as necessary to cover entire test area.
c. Testing agency must create a conductive electronic field over the area of traffic coating to be tested and electronically determine locations of discontinuities or leaks, if any, in the traffic coating.
d. Testing agency must provide survey report indicating locations of discontinuities, if any.

B. Final Traffic-Coating Inspection: Arrange for traffic-coating manufacturer's technical personnel to inspect membrane installation on completion.

1. Notify the Owner 48 hours in advance of date and time of inspection.

C. Waterproofing will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 PROTECTING AND CLEANING

A. Protect traffic coatings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 18 00 00

Task	Specification	Specification Description
07 18 13 00	07 18 00 00	Traffic Coatings
07 18 16 00	07 18 00 00	Traffic Coatings

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SECTION 07 19 00 00 - WATER REPELLENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrating water repellents.
2. Film-forming water repellents.
3. MPI-approved water repellents.

B. Related Requirements:

1. Section 030130 "Maintenance of Cast-in-Place Concrete" for high-build penetrating polymer sealers for exterior traffic surfaces.
2. Section 042000 "Unit Masonry" for integral water-repellent admixture for unit masonry assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's printed statement of VOC content.
2. Include manufacturer's standard colors.
3. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.
4. Include printout of current "MPI Approved Products List" for each product category specified in Part 2 that specifies water repellents approved by MPI, with the proposed product highlighted.

B. Samples: For each type[**and color**] of water repellent and substrate indicated, **12 by 12 inches (300 by 300 mm)** in size, with specified water-repellent treatment applied to half of each Sample.

C. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Applicator**][**testing agency**].

B. Product Certificates: For each type of water repellent.

C. Preconstruction Test Reports: For water-repellent-treated substrates.

D. Sample Warranty: For special warranty.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.

B. MPI Standards: Comply with MPI standards indicated and provide water repellents listed in its "MPI Approved Products List."

1.6 MOCKUPS

A. Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects[**, for preconstruction testing,**] and to set quality standards for materials and execution.

1. Locate mockups [**where indicated on Drawings**][**on masonry sample panels**][**on existing surfaces where directed by Architect**][**in locations that enable viewing under same conditions as the completed Work**], as directed by the Owner.

   a. Size: [**10 sq. ft. (0.93 sq. m)**][**25 sq. ft. (2.3 sq. m)**] each.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing of water repellents on [**field mockups**][**manufacturer's standard substrate assemblies**][**on existing substrate assemblies**].

1. In addition to verifying performance requirements, use mockups to verify manufacturer's written instructions for application procedure and optimum rates of product application to substrates.
2. Propose changes to materials and methods to suit Project.
3. Notify Architect [**seven**] days in advance of the dates and times when mockups will be tested, as directed by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **35 deg F (2 deg C)** and not more than **110 deg F (44 deg C)**, in accordance with manufacturer's written instructions.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.
3. Protect materials from direct sunlight.

1.9 FIELD CONDITIONS

A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied in accordance with manufacturers' written instructions and warranty requirements:

1. Concrete surfaces and mortar have cured for not less than 28 days.
2. Building has been closed in for not less than 30 days before treating wall assemblies.
3. Ambient temperature is above **40 deg F (4.4 deg C)** and below **100 deg F (37.8 deg C)** and will remain so for 24 hours.
4. Substrate is not frozen and substrate-surface temperature is above **40 deg F (4.4 deg C)** and below **100 deg F (37.8 deg C)**.
5. Rain or snow is not predicted within 24 hours.
6. Not less than [**24 hours**][**seven days**] have passed since surfaces were last wet.
7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which [**manufacturer**][**and**][**Applicator**] agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Water repellents must meet the following performance requirements as determined by [**preconstruction**]testing on[**manufacturer's standard**] substrates representing those indicated for this Project.

B. Water Absorption: Minimum [**80**][**90**] percent reduction of water absorption after 24 hours for treated compared to untreated specimens when tested in accordance with the following:

1. Cast-in-Place Concrete: ASTM C642.
2. Precast Concrete: ASTM C642.
3. Cast Stone: ASTM C1195.
4. Concrete Masonry Units: ASTM C140/C140M.
5. Clay Brick: ASTM C67/C67M.
6. Natural Stone: ASTM C97/C97M.
7. Portland Cement Plaster (Stucco): ASTM D6532.

C. Water-Vapor Transmission: Comply with one or both of the following:

1. Maximum [**10**] percent reduction in water-vapor transmission of treated compared to untreated specimens, in accordance with ASTM E96/E96M.
2. Minimum [**80**] percent water-vapor transmission of treated compared to untreated specimens, in accordance with ASTM D1653.

D. Water Penetration and Leakage through Masonry: Minimum [**90**] percent reduction in leakage rate of

treated compared to untreated specimens, in accordance with ASTM E514/E514M.

E. Durability: Maximum [**5**] percent loss of water-repellent performance after 2500 hours of weathering in accordance with ASTM G154 compared to water-repellent-treated specimens before weathering.

2.2 PENETRATING WATER REPELLENTS

A. Penetrating Low-VOC Silane Water Repellent: Clear, containing [**20**][**40**][**100**] percent or more active content of [**modified**]silane; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Chemical Products Industries, Inc**]
c. [**ChemMasters, Inc**]
d. [**Concrete Sealers USA**]
e. [**Dayton Superior Corporation**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Evonik Corporation**]
h. [**Foxfire Enterprises, Inc.**]
i. [**Ghostshield**]
j. [**LymTal International, Inc.**]
k. [**Master Builders Solutions**]
l. [**Nox-Crete Products Group**]
m. [**Pecora Corporation**]
n. [**PPG Paints; PPG Industries, Inc.**]
o. [**Price Research, Ltd. dba Charles Paint Research**]
p. [**PROSOCO, Inc**]
q. [**Specco Industries, Inc**]
r. [**Textured Coatings of America, Inc**]
s. [**Tnemec Company, Inc.**]
t. [**W. R. Meadows, Inc**]

B. Penetrating Silane Water Repellent: Clear, containing [**20**][**40**][**100**] percent or more active content of [**modified**]silane; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Chemical Products Industries, Inc**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Evonik Corporation**]
g. [**Fox Industries, Inc.**]

h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**LymTal International, Inc.**]
j. [**Master Builders Solutions**]
k. [**Nox-Crete Products Group**]
l. [**Pecora Corporation**]
m. [**PPG Paints; PPG Industries, Inc.**]
n. [**Price Research, Ltd. dba Charles Paint Research**]
o. [**PROSOCO, Inc**]
p. [**Specco Industries, Inc**]
q. [**Textured Coatings of America, Inc**]
r. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
s. [**Tnemec Company, Inc.**]

C. Penetrating Low-VOC Siloxane Water Repellent: Clear, containing [**10**][**12**] percent or more active content of [**modified**]siloxane; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cathedral Stone Products, Inc.**]
b. [**Concrete Sealers USA**]
c. [**Conproco Corporation**]
d. [**Dayton Superior Corporation**]
e. [**Evonik Corporation**]
f. [**Fabrikem Manufacturing Ltd.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**PPG Paints; PPG Industries, Inc.**]
i. [**Price Research, Ltd. dba Charles Paint Research**]
j. [**RainGuard Professional**]
k. [**SaverSystems**]
l. [**Specco Industries, Inc**]
m. [**Textured Coatings of America, Inc**]
n. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
o. [**United Gilsonite Laboratories (UGL)**]

D. Penetrating Siloxane Water Repellent: Clear, containing [**10**][**12**] percent or more active content of [**modified**]siloxane; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Conproco Corporation**]
b. [**Dayton Superior Corporation**]
c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
d. [**Evonik Corporation**]
e. [**Fabrikem Manufacturing Ltd.**]
f. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
g. [**PPG Paints; PPG Industries, Inc.**]

h. [**Price Research, Ltd. dba Charles Paint Research**]
i. [**PROSOCO, Inc**]
j. [**SaverSystems**]
k. [**Specco Industries, Inc**]
l. [**Textured Coatings of America, Inc**]
m. [**TK Products Construction Coatings, a Fenix Group SPC Company**]

E. Penetrating Low-VOC Silane/Siloxane-Blend Water Repellent: Clear, containing [**10**][**12**] percent or more active content of silane and siloxane blend with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**AWRC Corporation**]
c. [**Cathedral Stone Products, Inc.**]
d. [**Chemical Products Industries, Inc**]
e. [**Conproco Corporation**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Evonik Corporation**]
h. [**Fabrikem Manufacturing Ltd.**]
i. [**Fox Industries, Inc.**]
j. [**Foxfire Enterprises, Inc.**]
k. [**Ghostshield**]
l. [**Karnak Corporation**]
m. [**Kryton International, Inc.**]
n. [**Laticrete International, Inc.**]
o. [**LymTal International, Inc.**]
p. [**Master Builders Solutions**]
q. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
r. [**Pecora Corporation**]
s. [**PPG Paints; PPG Industries, Inc.**]
t. [**Price Research, Ltd. dba Charles Paint Research**]
u. [**PROSOCO, Inc**]
v. [**RainGuard Professional**]
w. [**SaverSystems**]
x. [**Sika Corporation**]
y. [**Symons; a Brand of Dayton Superior Corporation**]
z. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
aa. [**Tnemec Company, Inc.**]
bb. [**United Gilsonite Laboratories (UGL)**]
cc. [**V-Seal Concrete Sealers & Specialty Coatings**]
dd. [**Wacker Chemical Corporation**]

F. Penetrating Silane/Siloxane-Blend Water Repellent: Clear, containing [**10**][**12**] percent or more active content of silane and siloxane blend with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Chemical Products Industries, Inc**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Fabrikem Manufacturing Ltd.**]
e. [**Fox Industries, Inc.**]
f. [**Karnak Corporation**]
g. [**Kryton International, Inc.**]
h. [**Laticrete International, Inc.**]
i. [**LymTal International, Inc.**]
j. [**Master Builders Solutions**]
k. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
l. [**Pecora Corporation**]
m. [**PPG Paints; PPG Industries, Inc.**]
n. [**Price Research, Ltd. dba Charles Paint Research**]
o. [**PROSOCO, Inc**]
p. [**RainGuard Professional**]
q. [**SaverSystems**]
r. [**Sika Corporation**]
s. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
t. [**Tnemec Company, Inc.**]
u. [**Wacker Chemical Corporation**]

G. Penetrating Low-VOC Siliconate Water Repellent: Clear, methyl siliconate water repellent with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Concrete Sealers USA**]
b. [**Ghostshield**]
c. [**Moxie International**]
d. [**PROSOCO, Inc**]

H. Penetrating Water and Oil Repellent: Clear, oleophobic water repellent; with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Chemical Products Industries, Inc**]
c. [**ChemMasters, Inc**]
d. [**Concrete Sealers USA**]
e. [**Evonik Corporation**]
f. [**Ghostshield**]
g. [**Laticrete International, Inc.**]
h. [**Master Builders Solutions**]
i. [**PROSOCO, Inc**]
j. [**TK Products Construction Coatings, a Fenix Group SPC Company**]

I. Penetrating Water Repellent and Corrosion Inhibitor: Clear, containing [**100**] percent or more active content of modified [**silane**][**siloxane**] water repellent and corrosion inhibitor, with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**ChemMasters, Inc**]
c. [**Ghostshield**]

J. Penetrating Water Repellent for Calcareous Stone: Clear, modified silane with ethyl silicate, specially formulated for limestone and marble.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Evonik Corporation**]
c. [**PROSOCO, Inc**]

K. Penetrating Water Repellent Concentrate: Concentrated [**siloxane**][**silane**], for field dilution.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Chemical Products Industries, Inc**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Evonik Corporation**]
d. [**LymTal International, Inc.**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**PROSOCO, Inc**]

2.3 FILM-FORMING WATER REPELLENTS

A. Film-Forming Low-VOC Silicone Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; in a solvent- or waterborne solution containing not less than 3 and up to 7 percent solids by weight; and with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Professional Products of Kansas, Inc.**]

b. [**Specco Industries, Inc**]
c. [**United Gilsonite Laboratories (UGL)**]

B. Film-Forming Silicone Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; in a solvent- or waterborne solution containing not less than 3 and up to 7 percent solids by weight; and with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Professional Products of Kansas, Inc.**]
b. [**Specco Industries, Inc**]

C. Film-Forming Water Repellent for Masonry: [**Clear**][**Pigmented**], consisting of resins, acrylics, polymers, with 600 g/L or less of VOCs; for masonry block or brick.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
b. [**PPG Paints; PPG Industries, Inc.**]
c. [**SaverSystems**]
d. [**Textured Coatings of America, Inc**]

2. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Film-Forming Low-VOC Modified Acrylic Water Repellent: [**Clear**][**Pigmented**], breathing coating of acrylic resin, which may be enhanced with silane and siloxane resins; in a waterborne, solvent-borne, or acrylic emulsion solution containing less than 15 percent solids by volume; and with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ghostshield**]
b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
c. [**Nox-Crete Products Group**]
d. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
g. [**Specco Industries, Inc**]

2. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Film-Forming Modified Acrylic Water Repellent: [**Clear**][**Pigmented**], breathing coating of acrylic resins, which may be enhanced silane and siloxane resins; in a waterborne, solvent-borne, or acrylic emulsion solution containing less than 15 percent solids by volume; and with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
    b. [**Nox-Crete Products Group**]
    c. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
    d. [**PPG Paints; PPG Industries, Inc.**]
    e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    f. [**Specco Industries, Inc**]

2. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 MPI-APPROVED WATER REPELLENTS

A. Water Repellent, Clear (Paintable); MPI #34: Penetrating, clear water-repellent coating, for use on interior or exterior masonry, brick, and concrete surfaces, and that can be recoated with conventional paints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cloverdale Paint**]
    b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    c. [**PPG Paints; PPG Industries, Inc.**]
    d. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    e. [**United Gilsonite Laboratories (UGL)**]

2. VOC Content: [**600 g/L or less**][**400 g/L or less**][**150 g/L or less**][**Less than 51 g/L**].
3. MPI Green Performance Standard: [**GPS-1**][**GPS-2**].

B. Water Repellent, Clear (Not Paintable); MPI #117: Penetrating, silicone-oil type, clear water-repellent for interior or exterior masonry block or brick, not intended for recoating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    d. [**Sherwin-Williams Company (The)**]

2. VOC Content: [**600 g/L or less**][**350 g/L or less**][**200 g/L or less**][**Less than 51 g/L**].
3. MPI Green Performance Standard: [**GPS-1**][**GPS-2**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.

1. Verify that surfaces are clean and dry in accordance with water-repellent manufacturer's requirements. Check moisture content in [**three**] representative locations by method recommended by manufacturer.
2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
3. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level in accordance with water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, in accordance with repellent manufacturer's written instructions.

B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product in accordance with water-repellent manufacturer's written instructions.

1. Concrete-Based Substrates: Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents on [**cast-in-place concrete**][**precast concrete**][**cast stone**][**and**][**concrete masonry unit**] substrate [**in accordance with ASTM E1857**].
2. Clay Brick Masonry Substrate: [**ASTM D5703.**][**Section 040110 "Masonry Cleaning."**]
3. Natural Stone Substrate: [**ASTM C1515.**][**ASTM D5107.**][**Section 040110 "Masonry Cleaning."**]
4. Portland Cement Plaster (Stucco) Substrate: [**ASTM E1857**].

C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.

D. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.

E. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.

1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION OF WATER REPELLENTS

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply coating of water repellent on surfaces to be treated using [**15 psi (103 kPa) pressure spray with a fan-type spray nozzle**][**roller**][**or**][**brush**] to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.

1. At Contractor's option, first application of water repellent may be completed before installing [**precast concrete**][**and**][**cast stone**] units. Mask mortar and sealant bond surfaces to prevent water repellent from migrating onto adjacent joint surfaces. Remove masking after repellent has cured.

C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.4 FIELD QUALITY CONTROL

A. Testing of Water-Repellent Material: the Owner reserves the right to invoke the following procedure at any time and as often as the Owner deems necessary during the period when water repellent is being applied:

1. the Owner may engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance of water-repellent material with product requirements.
3. the Owner may direct Contractor to stop applying water repellents if test results show material being used does not comply with product requirements. Contractor to remove noncomplying material from Project site, pay for testing, and correct deficiency of surfaces treated with rejected materials, as approved by Architect, as directed by the Owner.

B. Coverage Test: In the presence of Architect, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application, as directed by the Owner.

1. Notify Architect [**seven**] days in advance of the dates and times when surfaces will be tested, as directed by the Owner.
2. Reapply water repellent until coverage test indicates complete coverage.

3.5 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application, in accordance with manufacturer's written cleaning instructions, as work progresses. Correct damage to work of other trades caused by water-repellent application, as directed by the Owner.

END OF SECTION 07 19 00 00

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Task	Specification	Specification Description
07 19 13 00	07 19 00 00	Water Repellents
07 19 16 00	07 19 00 00	Water Repellents

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SECTION 07 25 00 00 - WEATHER BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Weather barrier types.
2. Accessory materials.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show details of [**building paper**][**building wrap**][**drainage wrap**] at terminations, openings, and penetrations. Show details of flexible flashing applications.

C. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party-Certified Life-Cycle Assessment: For each product.
10. Health Product Declaration (HPD): For each product.
11. Health Product Declaration (HPD): Provide HPD.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For weather barrier, by a qualified testing agency.

B. Product Test Reports: For weather barrier, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

C. Evaluation Reports: Report Type: [**Water-resistive barrier**][**and**][**flexible flashing**], from ICC-ES.

D. Source Quality Control Reports: For weather barriers.

E. Field Quality Control Reports: For weather barriers.

F. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: [**Fabricator of products**][**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**], as directed by the Owner.

1.5 MOCKUPS

A. Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**to set quality standards for fabrication and installation**][**and**][**for preconstruction testing**], as directed by the Owner.

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver weather barrier materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

1.7 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit weather barrier materials to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.8 WARRANTY

A. Warranty Period: [**10**][**15**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WEATHER BARRIER TYPES

A. Building Paper:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]

2. Building Paper Materials: [**Type I, ASTM D226/D226M, (No. 15 asphalt-saturated organic felt),**

unperforated][**Type II, ASTM D226/D226M, (No. 30 asphalt-saturated organic felt), unperforated**][**Grade D, water-vapor-permeable, asphalt-saturated kraft building paper that complies with ICC-ES AC38**][**; except with water-resistance rating of not less than 1 hour**].

B. Building Wrap: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84; UV stabilized; and acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alpha ProTech**]
    b. [**Barricade Building Products**]
    c. [**Benjamin Obdyke Incorporated**]
    d. [**Dorken Systems Inc.**]
    e. [**DuPont de Nemours, Inc.**]
    f. [**Kingspan Insulation LLC**]
    g. [**PrimeSource Building Products, Inc.**]
    h. [**Typar; a Magnera Corporation brand**]

2. Building Wrap Materials: [**Type I, ASTM E2556/E2556M**][**Type I, ASTM E1677**][**Type II, ASTM E2556/E2556M**][**ICC-ES AC38**].
3. Composition Type: [**Perforated woven polyolefin**][**Polypropylene woven fabric with coating**][**Nonperforated, nonwoven polyolefin**].
4. Water-Vapor Permeance: Minimum [**75 perms (4300 ng/Pa x s x sq. m)**][**20 perms (1150 ng/Pa x s x sq. m)**][**11 perms (629 ng/Pa x s x sq. m)**][**8 perms (460 ng/Pa x s x sq. m)**] in accordance with ASTM E96/E96M, Desiccant Method (Procedure A).
5. Air Permeance: Not more than [**0.001 cfm/sq. ft. at 1.57 lbf/sq. ft. (0.005 L/s x sq. m at 75 Pa)**][**0.004 cfm/sq. ft. at 1.57 lbf/sq. ft. (0.02 L/s x sq. m at 75 Pa)**] when tested in accordance with ASTM E2178.
6. Allowable UV Exposure Time: Not more than [**120**][**180**][**270**] days.
7. Flame Propagation Test: Materials and construction to be as tested in accordance with NFPA 285.

C. Drainage Wrap: Dimensional water-resistive barrier that also creates a drainage plane; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84; and acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alpha ProTech**]
    b. [**Barricade Building Products**]
    c. [**Benjamin Obdyke Incorporated**]
    d. [**DuPont de Nemours, Inc.**]
    e. [**Kingspan Insulation LLC**]

2. Drainage Wrap Materials: [**Type I, ASTM E2556/E2556M**][**Type I, ASTM E1677**][**Type II, ASTM E2556/E2556M**][**ICC-ES AC38**].
3. Composition Type: [**Nonperforated**][**Nonwoven polyolefin with nondirectional drainage**

pattern].

4. Water-Vapor Permeance: Minimum [**55 perms (3147 ng/Pa x s x sq. m)**][**35 perms (2002 ng/Pa x s x sq. m)**][**15 perms (858 ng/Pa x s x sq. m)**][**5 perms (286 ng/Pa x s x sq. m)**] in accordance with ASTM E96/E96M, Desiccant Method (Procedure A).
5. Air Permeance: Maximum [**0.004 cfm/sq. ft. at 0.3 inch wg (0.02 L/s x sq. m at 75 Pa)**] when tested in accordance with ASTM E2178.
6. Drainage: Not less than [**90**][**95**][**98**] percent when tested in accordance with ASTM E2273.
7. Allowable UV Exposure Time: Not more than [**120**][**180**] days.

2.2 ACCESSORY MATERIALS

A. Requirement: Provide primers, fasteners, seam tapes, flashing, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by weather barrier manufacturer to produce a complete weather barrier assembly and that are compatible with primary weather barrier material and adjacent construction to which they may seal.

B. Drainage Mat: Free-draining, polymer-strand mesh sheets or strips materials to provide a continuous open space behind exterior cladding.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advanced Building Products Inc.**]
    b. [**CavClear; a division of Archovations, Inc.**]
    c. [**Dorken Systems Inc.**]
    d. [**DuPont de Nemours, Inc.**]
    e. [**Keene Building Products**]
    f. [**Mortar Net Solutions**]
    g. [**Stuc-O-Flex International, Inc.**]
    h. [**Wire-Bond**]

2. Drainage Mat Size: Thickness not less than [**full depth of cavity**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**] and installed to full height of cavity, [**with additional strips 4 inches (102 mm) high above flashing locations and thick enough to fill entire depth of cavity**] to maintain a continuous open space behind exterior cladding.
3. Location: [**Underneath siding**][**Behind portland cement plaster**][**Behind adhered masonry veneer**][**As indicated on Drawings**].

C. Drainage Accessories:

1. Component: [**Furring strips**] installed between water-resistive barrier and exterior cladding to create a continuous open space behind exterior cladding.

PART 3 - EXECUTION

3.1 INSTALLATION OF WEATHER BARRIERS

A. Weather Barriers:

1. Building Paper: Comply with manufacturer's written instructions and warranty requirements.
2. Building Wrap or Drainage Wrap: Comply with manufacturer's written instructions and warranty requirements.
3. Drainage Material: Comply with manufacturer's written instructions.

B. Install weather barrier accessories for a complete installation with weather barriers in accordance with manufacturer's written instructions.

END OF SECTION 07 25 00 00

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SECTION 07 26 00 00 - VAPOR RETARDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyethylene vapor retarders.
2. Reinforced-polyethylene vapor retarders.
3. Fire-retardant, reinforced-polyethylene vapor retarders.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for under-slab vapor retarders.
2. Section 072100 "Thermal Insulation" for vapor retarders integral with insulation products.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Polyethylene vapor retarders.
2. Reinforced-polyethylene vapor retarders.
3. Fire-retardant, reinforced-polyethylene vapor retarders.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 POLYETHYLENE VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D4397, [**6-mil- (0.15-mm-)**][**10-mil- (0.25-mm-)**] thick sheet, with maximum permeance rating of **0.1 perm (5.7 ng/Pa x s x sq. m)**.

2.2 REINFORCED-POLYETHYLENE VAPOR RETARDERS

A. Reinforced-Polyethylene Vapor Retarders: Sheet with outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than [**20 lb/1000 sq. ft. (9 kg/100 sq. m)**], with maximum permeance rating of **0.1 perm (5.7 ng/Pa x s x sq. m)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ISI Building Products**]
b. [**Reef Industries, Inc.**]
c. [**Viaflex**]
d. [**W. R. Meadows, Inc**]

2.3 FIRE-RETARDANT, REINFORCED-POLYETHYLENE VAPOR RETARDERS

A. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: Sheet with outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or polyester scrim and weighing not less than [**20 lb/1000 sq. ft. (9 kg/100 sq. m)**], with maximum permeance rating of **0.1 perm (5.7 ng/Pa x s x sq. m)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]
b. [**Viaflex**]

2. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of [**75 and 200**], respectively, per ASTM E84.

2.4 ACCESSORIES

A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.2 INSTALLATION OF VAPOR RETARDERS ON FRAMING

A. Place vapor retarders on side of construction indicated on Drawings.

B. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated

substrates, including those filled with loose-fiber insulation.

C. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.

D. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.3 INSTALLATION OF VAPOR RETARDERS IN CRAWL SPACES

A. Install vapor retarders over prepared grade. Lap joints a minimum of **12 inches (305 mm)** and seal with manufacturer's recommended tape. Install second layer over pathways to equipment.

B. Extend vapor retarder over footings and seal to foundation wall or grade beam with manufacturer's recommended tape.

1. Extend vapor retarder vertically minimum [**16 inches (406 mm)**][**24 inches (610 mm)**] above top of footing.

C. Seal around penetrations such as utilities and columns in order to create a monolithic, airtight membrane at grade surface, perimeter, and all vertical penetrations.

3.4 PROTECTION

A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION 07 26 00 00

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Task	Specification	Specification Description
07 26 00 00	07 25 00 00	Weather Barriers
07 26 13 00	06 10 00 00	Rough Carpentry
07 26 13 00	07 25 00 00	Weather Barriers
07 26 13 00	07 26 00 00	Vapor Retarders
07 27 00 00	07 25 00 00	Weather Barriers
07 27 23 00	07 25 00 00	Weather Barriers

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SECTION 07 61 00 00 - SHEET METAL ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet metal roofing material.
2. Underlayment.

B. Related Requirements:

1. Section 074293 "Soffit Panels" for manufactured metal panels used in horizontal soffit applications.
2. Section 077100 "Roof Specialties" for manufactured [**fasciae**][**copings**] that are not part of sheet metal roofing.
3. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.2 COORDINATION

A. Coordinate sheet metal roofing layout and seams with sizes and locations of roof curbs, equipment supports, equipment provided, and roof penetrations.

B. Coordinate sheet metal roofing installation with rain drainage work, flashing, trim, and construction of roofing substrate, parapets, walls, and other adjoining work to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review structural loading limitations of substrates during and after roofing installation.
3. Review insulation, air barrier, vapor retarder, and underlayment requirements.
4. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affect sheet metal roofing.
5. Review requirements for insurance and certificates if applicable.
6. Review roof observation and repair procedures after sheet metal roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For sheet metal roofing panels. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and panel installation layouts, expansion joint locations, points of fixity, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include details for forming, including seams and dimensions.
4. Include details for joining and securing, including layout and spacing of fasteners, cleats, and other attachments. Include pattern of seams.
5. Include details of expansion joints, including showing direction of expansion and contraction from points of fixity.
6. Include details of roof penetrations.
7. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, corners, flashings, and counterflashings.
8. Include details of special conditions.
9. Include details of connections to adjoining work.
10. Detail the following accessory items, at scale of not less than [**1-1/2 inches per 12 inches (1:10)**][**3 inches per 12 inches (1:5)**]:

    a. Flashing and trim.
    b. Roof curbs.

C. Samples: For each exposed product and for each color and texture specified, **12 inches (300 mm)** long by actual width.

D. Samples for Initial Selection: For each type of sheet metal with factory-applied finishes.

1. Include Samples of trim and accessories involving finish or color selection.

E. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Roofing: **12 inches (300 mm)** long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, [**battens,**]and other attachments.
2. Trim and Metal Closures: **12 inches (300 mm)** long and in required profile. Include fasteners and other exposed accessories.
3. Other Accessories: **12-inch- (300-mm-)** long Samples for each type of other accessory.

F. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:

1. Sheet metal roofing, seam locations, and attachments.
2. Roof hatches.
3. Equipment supports, pipe supports, and penetrations.
4. Lighting fixtures and cable runs.
5. Snow guards.
6. Items mounted on roof curbs.
7. Details for penetrations.

B. Qualification Statements: For [**Installer**][**fabricator**].

1. Include listing of completed projects of comparable scale of this Project, including name, address, telephone, and contact person for Architect, and name, address, telephone number, and contact person for building the Owner, as directed by the Owner.

C. Product Test Reports: For self-adhering, high-temperature underlayment, from ICC-ES.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal roofing and accessories.

B. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.7 QUALITY ASSURANCE

A. Roof Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Metal Panel Roof Systems Installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified Metal Panel Roof Systems Installers**].

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof area and eave as indicated on Drawings, including[**underlayment,**] attachments, and accessories.

a. Size: Approximately [**12 feet (3.5 m) long by 6 feet (1.75 m)**][**48 inches (1200 mm) square**][**12 feet (3.5 m) square**].
b. Include [**each type of exposed seam and seam termination**][**fascia**][**soffit**][**gable end and rake**].

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal roofing materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal roofing materials away from uncured concrete and masonry.
2. Protect stored sheet metal roofing materials from contact with water.

B. Protect strippable protective covering on sheet metal roofing from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal roofing installation.

C. Copper Roof Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.10 WARRANTY

A. Roofing System Installer's Warranty: Submit Roofing System Installer's warranty, on warranty form at end of this Section, signed by Roofing System Installer, covering the Work of this Section, including all components of roofing system, such as fasteners, adhesives, sheet metal roofing, and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

B. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal roofing that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Sheet metal roofing system, including, but not limited to, metal roof panels, cleats, anchors and fasteners, sheet metal flashing integral with sheet metal roofing, fascia panels, trim[**battens**], underlayment, and accessories, is to comply with requirements without failure due to defective manufacture, fabrication, or installation, or due to other defects in construction. Sheet metal roofing is to remain watertight.

B. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or indicated on Drawings.

C. Copper Roofing Standard: Comply with CDA Publication A4050. Conform to dimensions and profiles shown unless more stringent requirements are specified or indicated on Drawings.

D. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

E. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

F. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Energy Performance: Provide sheet metal roofing meeting one of the following when tested in accordance with CRRC-1:

1. Three-year, aged, solar reflectance of not less than [**0.63**][**0.55**] and emissivity of not less than [**0.75**].
2. Three-year, aged, Solar Reflectance Index (SRI) of not less than [**75**][**64**] when calculated in accordance with ASTM E1980.

H. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 SHEET METAL ROOFING MATERIAL

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide [**zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 (Z275) coating designation**][**aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275)**]; with [**smooth, flat**][**embossed**] surface; prepainted by coil-coating process to comply with ASTM A755/A755M.

1. Thickness: Nominal [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**] unless otherwise indicated.

   a. Batten Caps: Nominal **0.028 inch (0.71 mm)** thick.

2. Exposed Coil-Coated Finish:

   a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   c. Mica Fluoropolymer: Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   d. Metallic Fluoropolymer: Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   e. FEVE Fluoropolymer: Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As**

selected by Architect from manufacturer's full range], as directed by the Owner.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Sheet: **ASTM B209 (ASTM B209M)** alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with [**smooth, flat**][**embossed**] surface.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**] unless otherwise indicated.

    a. Batten Caps: **0.050 inch (1.27 mm)** thick.

2. As-Milled Finish: [**Mill**][**One-side bright mill**][**Standard one-side bright**][**Standard two-side bright**].
3. Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.
4. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of **0.2 mil (0.005 mm)**.
5. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
    b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
    c. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
    d. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
    e. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEFE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
    f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

6. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
7. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.

D. Copper Sheet: ASTM B370 cold-rolled copper sheet, H00 temper.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hussey Copper Ltd.**]
    b. [**Revere Copper Products, Inc**]

2. Weight (Thickness): [**16 oz./sq. ft. (0.55 mm thick)**][**20 oz./sq. ft. (0.70 mm thick)**] unless otherwise indicated.

    a. Batten Caps: **20 oz./sq. ft. (0.70 mm)** thick.

3. Nonpatinated Exposed Finish: Mill.
4. Nonpatinated Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA AMP 500 "Metal Finishes Manual for Architectural and Metal Products."

    a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac" [**waterborne**][**solvent-borne**] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.
    b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac" [**waterborne**][**solvent-borne**] air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.

5. Prepatinated Copper-Sheet Finish: [**Dark brown**][**Verdigris**], prepatinated in accordance with ASTM B882.

E. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B370 cold-rolled copper sheet, H00 temper, coated on both sides with zinc-tin alloy (50 percent zinc, 50 percent tin).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Revere Copper Products, Inc**]

2. Weight (Thickness): [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.70 mm)**] uncoated, with **0.787-mil (0.020-mm)** coating thickness applied to each side.

    a. Batten Caps: **20 oz./sq. ft. (0.70 mm)** uncoated, with **0.787-mil (0.020-mm)** coating thickness applied to each side unless otherwise indicated.

F. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**], dead soft, fully annealed; with [**smooth, flat**][**embossed**] surface.

1. Thickness: [**0.0156 inch (0.396 mm)**][**0.0188 inch (0.477 mm)**] unless otherwise indicated.

    a. Batten Caps: **0.0188 inch (0.477 mm)** thick.

2. Finish: [**ASTM A480/A480M, No. 2D (dull, cold rolled)**][**ASTM A480/A480M, No. 2B (bright,**

cold rolled)][ASTM A480/A480M, No. 3 (coarse, polished directional satin)][ASTM A480/A480M, No. 4 (polished directional satin)].

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches. Run grain of directional finishes with long dimension of each piece.
c. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

G. Copper-Clad Stainless Steel Sheet: ASTM B506, annealed temper O61.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Heyco Metals**]
b. [**SEMCO Southeastern Metals, A Gibraltar Industries Company**]

2. Thickness: [**0.016 inch (0.40 mm)**] unless otherwise indicated.

a. Batten Caps: [**0.018 inch (0.46 mm)**] thick.

H. Zinc Sheet: [**99.995 percent electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent)][Zinc, 99 percent pure, alloyed with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum**]; with manufacturer's standard factory-applied, flexible, protective back coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Artazn LLC**]
b. [**Rheinzink America**]

2. Thickness: [**0.027 inch (0.70 mm)**][**0.032 inch (0.81 mm)**] unless otherwise indicated.

a. Batten Caps: **0.032 inch (0.80 mm)** thick.

3. Finish: [**Bright rolled**][**Preweathered gray**][**Preweathered black**].

I. Titanium Sheet: ASTM B265, Grade 1; with [**smooth, flat**][**embossed**] surface.

1. Thickness: [**0.015 inch (0.38 mm)**][**0.020 inch (0.51 mm)**] unless otherwise indicated.

a. Batten Caps: **0.020 inch (0.51 mm)** thick.

2. Finish: [**Low**][**Medium**] matte.
3. Color Anodic Finish (Light-Interference Phenomenon): [**Silver**][**Gold**][**Purple**][**Blue**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range of colors and color densities**].

2.3 UNDERLAYMENT

A. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; acceptable to authorities having jurisdiction for use as underlayment in roofing system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Intertape Polymer Group**]
c. [**Kirsch Building Products**]
d. [**SDP Advanced Polymer Products Inc.**]

B. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils (0.76 mm)** thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATAS International, Inc.**]
b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
c. [**GCP Applied Technologies Inc.**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**Owens Corning**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Protecto Wrap Company**]
h. [**SDP Advanced Polymer Products Inc.**]

2. Thermal Stability: Stable after testing at **220 deg F (111 deg C)**; ASTM D1970/D1970M.
3. Low-Temperature Flexibility: Passes after testing at minus **20 deg F (minus 29 deg C)**; ASTM D1970/D1970M.

C. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.

D. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

E. Ventilation Mat: **0.40-inch (10.16-mm-)** thick, three-dimensional nylon mat.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Low & Bonar PLC**]
b. [**Rheinzink America**]

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners[**solder**], protective coatings, sealants, and other miscellaneous items as required for complete roofing system and as recommended by primary sheet metal manufacturer unless otherwise indicated.

B. Wood Battens: Lumber in accordance with requirements for nailers for roofing in Section 061000 "Rough Carpentry."

C. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. General:

a. Exposed Fasteners: Heads matching color of sheet metal roofing, using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of roofing.
b. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed; with hex-washer head.
c. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
5. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
6. Fasteners for Zinc Sheet: Series 300 stainless steel[**or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M**].
7. Fasteners for Titanium Sheet: Titanium or Series 300 stainless steel.

D. Solder:

1. For Zinc-Coated (Galvanized) Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead**][**with maximum lead content of 0.2 percent**].
2. For Copper or Copper-Clad Stainless Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead**][**with maximum lead content of 0.2 percent**].
3. For Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**], with acid flux of type recommended by stainless steel sheet manufacturer.
4. For Zinc-Tin Alloy-Coated Copper: ASTM B32, 100 percent tin, with maximum lead content of 0.2 percent, as recommended by sheet metal manufacturer.
5. For Zinc: ASTM B32, [**40 percent tin and 60 percent lead with low antimony,**][**with maximum lead content of 0.2 percent,**] as recommended by zinc manufacturer.

E. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.

F. Elastomeric Sealant: ASTM C920, elastomeric [**polyurethane**][**polysulfide**][**silicone**] polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal roofing and remain watertight.

G. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187.

I. Underlayment Adhesive:

1. Cold-Applied Asphalt Adhesive: ASTM D3019, Type III, asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with underlayment.
2. Cold-Applied Polymer-Modified Asphalt Adhesive: Underlayment manufacturer's standard solvent-and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with underlayment.
3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.5 ACCESSORIES

A. Sheet Metal Accessories: Provide components required for complete sheet metal roofing assembly, including trim, fasciae, corner units, clips, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items. Match material and finish of sheet metal roofing unless otherwise indicated.

1. Cleats: Intermittent and continuous attachment devices for mechanically seaming into joints and formed from the following materials and thicknesses unless otherwise indicated:

   a. Metallic-Coated Steel or Aluminum Roofing: [**0.0250-inch- (0.635-mm-)**] thick stainless steel.
   b. Copper or Zinc-Tin Alloy-Coated Copper Roofing: [**16-inch- (0.55-mm-)**][**20-inch- (0.70-mm-)**] thick copper sheet.
   c. Stainless Steel or Titanium Roofing: [**0.0250-inch- (0.635-mm-)**] thick stainless steel.
   d. Copper-Clad Stainless Steel Roofing: [**0.024-inch- (0.61-mm-)**] thick, copper-clad stainless steel.
   e. Zinc Roofing: Manufacturer's preformed stainless steel cleats.

2. Expansion-Type Cleats: Cleats of a design that allows longitudinal movement of roof panels without stressing panel seams; of same material as other cleats.
3. Backing Plates: Plates at roofing splices, fabricated from material recommended by SMACNA's "Architectural Sheet Metal Manual."
4. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin foam or closed-cell laminated polyethylene; minimum **1-inch- (25-mm-)** thick, flexible-closure strips; cut or premolded to match sheet metal roofing profile. Provide closure strips where necessary to ensure weathertight construction.
5. Flashing and Trim: Formed from same material and with same finish as sheet metal roofing, minimum [**0.018 inch (0.46 mm)**] thick.

B. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

C. Roof Curbs: Fabricated from same material and finish as sheet metal roofing, minimum thickness [**matching the sheet metal roofing**] with bottom of skirt profiled to match roof panel and seam profiles; with weatherproof top box and integral full-length cricket.

1. Fabricate curb subframing of nominal [**0.062-inch- (1.59-mm-)**] thick, angle-, C- or Z-shaped, galvanized-steel or stainless steel sheet.
2. Fabricate curb and subframing to withstand indicated loads of size and height indicated.
3. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
4. Insulate curbs with [**1-inch- (25-mm-)**] thick, rigid insulation.
5. Provide treated wood nailers at tops of curbs.

2.6 FABRICATION

A. Custom-Fabricated Sheet Metal Roofing: Comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions (panel width and seam height), geometry, metal thickness, and other characteristics of installation. Fabricate sheet metal roofing and accessories in shop to greatest extent possible.

B. Flat-Seam Sheet Metal Roofing: Form flat-seam panels from metal sheets [**20 by 28 inches (508 by 710 mm)**] with **1/2-inch (13-mm)** notched and folded edges.

C. Standing-Seam Sheet Metal Roofing: Form standing-seam panels with finished seam height [**of 1 inch (25 mm)**][**of 1-1/2 inches (38 mm)**][**as indicated**].

D. Batten-Seam Sheet Metal Roofing: Form batten-seam panels with edges turned up [**2-1/8 inches (54 mm)**][**as indicated**] and with **1/2-inch (13-mm)** flange turned toward center of pan.

E. Horizontal-Seam (Bermuda-Type) Sheet Metal Roofing: Form horizontal-seam (Bermuda-type) panels with upper edges of lower panels turned up and extending **1/2 inch (13 mm)** above continuous horizontal steps in substrate.

F. Fabrication Tolerances: [**Fabricate sheet metal roofing that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.**][**Fabricate sheet metal roofing that is capable of installation to tolerances specified in MCA's "Metal Roof Installation Manual."**]

G. Form exposed sheet metal work to fit substrates with little oil canning; free of buckling and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.

1. Lay out sheet metal roofing, so transverse seams, if required, are made in direction of flow, with higher panels overlapping lower panels.
2. Fold and cleat eaves and transverse seams in shop.
3. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements indicated on Drawings and as required for leakproof construction.

H. Built-in Gutters (Integral Gutters): Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.

1. Fabricate in minimum **96-inch- (2400-mm-)** long sections.

2. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
3. Fabricate gutters with built-in expansion joints.

I. Expansion Provisions: Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work.

1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

J. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant in accordance with SMACNA's "Architectural Sheet Metal Manual."

K. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item required. Obtain field measurements for accurate fit before shop fabrication.

1. Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
2. Seams: Fabricate nonmoving seams with flat-lock seams. [**Tin edges to be seamed, form seams, and solder.**][**Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.**][**Rivet joints where necessary for strength.**]
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices of sizes recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

L. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking, that tops of fasteners are flush with surface, and that installation is within flatness tolerances required for finished roofing installation.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored, and that provision has been made for drainage, flashings, and penetrations through sheet metal roofing.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating sheet metal roofing to verify actual locations of penetrations relative to seam locations of sheet metal roofing before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Lay out panel arrangement, and [**nail battens to wood sheathing**][**screw battens to wood sheathing**][**screw battens to metal deck**] before installation of sheet metal roofing.

1. Space fasteners not more than [**18 inches (460 mm)**] o.c.

3.3 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Apply from eave to ridge.
2. Apply on roof not covered by self-adhering sheet underlayment.
3. Lap horizontal joints not less than **4 inches (100 mm)**.
4. Lap end joints not less than **12 inches (300 mm)**.

B. Self-Adhering High-Temperature Sheet Underlayment:

1. Install self-adhering high-temperature sheet underlayment, wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days of installation.
8. Install self-adhering high-temperature underlayment at the following locations:

    a. Over entire roof.
    b. Roof perimeter for a distance up from eaves of [**24 inches (600 mm)**][**36 inches (910 mm)**] beyond interior wall line.
    c. Valleys, from lowest to highest point, for a distance on each side of [**18 inches (460 mm)**].
    d. Rake edges for a distance of [**18 inches (460 mm)**].
    e. Hips and ridges for a distance on each side of [**12 inches (300 mm)**].
    f. Roof-to-wall intersections for a distance from wall of [**18 inches (460 mm)**].
    g. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of [**18 inches (460 mm)**].
    h. Below entire area of integral gutters, up from eaves a minimum of [**36 inches (910 mm)**] beyond interior wall line, but not less than [**12 inches (300 mm)**] up from ridge side of gutter.
    i. Directional transitions for a distance of [**12 inches (300 mm)**] in each direction.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal roofing.

1. Install in shingle fashion to shed water, with lapped joints of not less than **4 inches (100 mm)**.
2. Apply from eave to ridge.
3. Apply on roof not covered by self-adhering sheet underlayment.

D. Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal roofing and related flashing.

1. Install in shingle fashion to shed water, with lapped joints of not less than **4 inches (100 mm)**.

E. Install ventilation mat over underlayment before installing sheet metal roofing and related flashing.

F. Install flashings to cover [**underlayment**][**slip sheet**][**ventilation mat**] in accordance with requirements in Section 076200 "Sheet Metal Flashing and Trim."

3.4 INSTALLATION, GENERAL

A. Install sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners[**solder**], protective coatings, separators, sealants, and other miscellaneous items as required for complete roofing system.
2. Install sheet metal roofing true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of [**solder**][**welds**][**sealant**].
3. Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Do not field cut sheet metal roofing by torch.
5. Provide metal closures at [**peaks**][**rake edges**][**rake walls**][**eaves**] each side of ridge[**and hip**] caps.
6. Flash and seal sheet metal roofing with closure strips at eaves, rakes, and perimeter of all openings. Fasten with self-tapping screws.
7. Locate and space fastenings in uniform vertical and horizontal alignment. Predrill panels for fasteners.
8. Install ridge[**and hip**] caps as sheet metal roofing work proceeds.
9. Lap metal flashing over sheet metal roofing to direct moisture to run over and off roofing.
10. Do not use graphite pencils to mark metal surfaces.

B. Thermal Movement: Rigidly fasten metal roof panels to structure at only one location for each panel.

1. Allow remainder of panel to move freely for thermal expansion and contraction.
2. Point of Fixity: Fasten each panel along a single common line of fixing located at [**eave**][**ridge**][**center of panel length**][**locations indicated on Drawings**].
3. Avoid attaching accessories through roof panels in manner that inhibits thermal movement.

C. Fasteners: Use fastener sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws**][**substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance**].

D. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended in SMACNA's "Architectural Sheet Metal Manual."

1. Coat concealed side of [**uncoated-aluminum**][**stainless steel**] sheet metal roofing with bituminous coating where roofing contacts wood, ferrous metal, or cementitious construction.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Fasciae:

1. Align bottom of sheet metal roofing and fasten with blind rivets, bolts, or self-tapping screws.
2. Flash and seal sheet metal roofing with closure strips where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

3.5 INSTALLATION OF SHEET METAL ROOFING

A. Install sheet metal roofing system with lines and corners of exposed units true and accurate.

1. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering metal temper and reflectivity.
2. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
3. Fold back sheet metal to form hem on concealed side of exposed edges unless otherwise indicated.

B. Install cleats to hold sheet metal roofing panels in position.

1. Attach each cleat with at least two fasteners to prevent rotation.
2. Space cleats not more than [**12 inches (300 mm)**] o.c.
3. Bend tabs over fastener head.
4. Provide expansion-type cleats for roof panels that exceed **30 feet (9.1 m)** in length.

C. Seal joints as required for watertight construction. For roofing with 3:12 slopes or less, use cleats at transverse seams.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than **1 inch (25 mm)** into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.
e. Do not install sealant-type joints at temperatures below **40 deg F (4 deg C)**.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pre-tin edges of sheets with solder to a width of **1-1/2 inches (38 mm)**; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
2. Do not solder [**metallic-coated steel**][**aluminum**][**titanium**] sheet.
3. Do not pre-tin zinc-tin alloy-coated copper.
4. Do not use torches for soldering.
5. Heat surfaces to receive solder, and flow solder into joint.

a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

6. Stainless Steel Soldering:

a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.

b. Promptly remove acid flux residue from metal after tinning and soldering.
c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.

E. Rivets: Rivet joints in [**uncoated aluminum**][**zinc**] where necessary for strength.

F. Flat-Seam Roofing:

1. Attach flat-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
2. After panels are in place, mallet seams tight and solder.
3. Attach roofing panels with cleats spaced not more than [**24 inches (600 mm)**] o.c. Lock and solder panels to base flashing.
4. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at [**12-inch (300-mm)**] o.c. spacing. Lock panels to edge flashing and [**solder**][**apply sealant**].

G. Standing-Seam Roofing:

1. Attach standing-seam metal panels to substrate with double-fastened cleats spaced at [**12 inches (300 mm)**] o.c.
2. Install panels reaching from eave to ridge before moving to adjacent panels.

   a. Where transverse joints are required, stagger joints in adjacent panels not less than **48 inches (1200 mm)**.

3. Before panels are interlocked, apply continuous bead of sealant to top of flange of lower panel.
4. Lock standing seams by folding over twice, so cleat and panel edges are completely engaged.
5. Lock each panel to panel below with [**soldered**][**sealed**] transverse seam.
6. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
7. Loose-lock panels at eave edges to continuous edge flashing exposed **24 inches (600 mm)** from roof edge.

   a. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at [**12-inch (305-mm)**] o.c. spacing.
   b. Lock panels to edge flashing.

8. [**Leave seams upright**][**Fold over seams**] after locking at ridges and hips.

H. Batten-Seam Roofing:

1. Attach batten-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
2. Hold cleats in place with battens, and fold edges of cleats over to hold panels.
3. After panels are in place and before batten cap is installed, apply continuous bead of sealant to top of upturned flanges of each panel.
4. Install batten cap covering batten and panel edges, and fold batten cap and panel together, so batten cap and panel edges are completely engaged in seams.
5. Hook each panel to panel below with [**soldered**][**sealed**] transverse seam.
6. Splay upturned edges of panels at a slightly obtuse angle, so pan-bottom width is slightly narrower than space between battens, to provide expansion capability.
7. Close batten ends with metal closures. Fold together with panel edges and end of batten cap.
8. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
9. Loose-lock panels at eave edges to continuous-edge flashing exposed **24 inches (600 mm)** from

roof edge.

a. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at [12-inch (305-mm)] o.c. spacing.
b. Lock panels to edge flashing.

I. Horizontal-Seam (Bermuda-Type) Roofing:

1. Attach horizontal-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
2. Attach cleats along continuous horizontal steps in substrate, with cleats at [8-inch (203-mm)] o.c. spacing.
3. Lock lower edge of each panel to turned-up upper edge of panel below, folding seam over to engage cleat and panel edges.
4. After first fold, mallet seams against substrate, leaving joint slightly angled over lower panel to form drip.
5. Hook end of each panel to adjacent panel with [**soldered**][**sealed**] cross seam.
6. Hook panel at eave edge to continuous cleat.
7. Join ridges and hips with a standing seam, and [**leave seams upright**][**fold over seams**] after locking.

J. Built-in Gutters:

1. Anchor back edge of gutter with continuous cleat.
2. Provide expansion joints at locations indicated on Drawings, but not less than 50 feet (14 m) on center.
3. Join gutter sections with soldered joints.

a. Join sections with lapped joints sealed with sealant where required for expansion.

4. Provide for thermal expansion.
5. Slope gutters to drainage points.
6. Provide end closures and seal watertight with sealant.
7. Install self-adhering, high-temperature sheet underlayment inside built-in gutter as indicated on Drawings.

a. Extend self-adhering, high-temperature sheet underlayment to eave drip edges and beneath roof underlayment.
b. Lap edges 2 inches (50 mm).
c. Lap ends 4 inches (100 mm).

3.6 INSTALLATION OF ACCESSORIES

A. Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion.

1. Coordinate installation with flashings and other components.
2. Install components required for complete sheet metal roofing assembly, including trim, seam covers, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items.
3. Install accessories integral to sheet metal roofing that are specified in Section 076200 "Sheet Metal Flashing and Trim" to comply with that Section's requirements.

B. Flashing and Trim: Comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual."

1. Provide concealed fasteners where possible, and install units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
3. Install flashing and trim as required to seal against weather and to provide finished appearance, including, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
4. Install continuous strip of self-adhering underlayment at edge of continuous flashing overlapping self-adhering underlayment, where "continuous seal strip" is indicated in SMACNA's "Architectural Sheet Metal Manual" and on Drawings.
5. Install exposed flashing and trim without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
6. Install sheet metal flashing and trim to fit substrates, and to result in waterproof and weather-resistant performance.
7. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

    a. Space expansion joints at maximum of **10 feet (3 m)** with no joints within **24 inches (600 mm)** of corner or intersection.
    b. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, and filled with butyl sealant concealed within joints.
    c. Use lapped expansion joints only where indicated on Drawings.

C. Pipe Flashing: Form flashing around pipe penetration and sheet metal roofing. Fasten and seal to sheet metal roofing as recommended in SMACNA's "Architectural Sheet Metal Manual."

D. Roof Curbs: Install flashing around bases where curbs meet sheet metal roofing.

3.7 INSTALLATION TOLERANCES

A. Installation Tolerances: [**Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.**][**Shim and align sheet metal roofing within installed tolerances specified in MCA's "Metal Roof Installation Manual."**]

3.8 CLEANING

A. Remove temporary protective coverings and strippable films as sheet metal roofing is installed unless otherwise indicated in manufacturer's written installation instructions.

B. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

C. On completion of sheet metal roofing installation, clean finished surfaces as recommended by sheet metal roofing manufacturer.

D. Clean and neutralize flux materials. Clean off excess solder.

E. Clean off excess sealants.

3.9 PROTECTION

A. Prohibit traffic of any kind on installed sheet metal roofing.

B. Maintain sheet metal roofing in clean condition during construction.

C. Replace sheet metal roofing components that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as directed by the Owner.

3.10 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
8. Date of Substantial Completion:

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have

notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 61 00 00

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Task	Specification	Specification Description
07 61 13 00	07 61 00 00	Sheet Metal Roofing
07 61 16 00	07 61 00 00	Sheet Metal Roofing
07 61 19 00	07 61 00 00	Sheet Metal Roofing

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SECTION 07 62 00 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet metal materials.
2. Underlayment.
3. Miscellaneous materials.
4. Roof-drainage sheet metal fabrications.
5. Sloped roof sheet metal fabrications.
6. Wall sheet metal fabrications.
7. Miscellaneous sheet metal fabrications.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.
3. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
4. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
5. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
6. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies subject to vehicular traffic.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Plans, elevations, sections, and attachment details.
2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.

3. Identification of material, thickness, weight, and finish for each item and location in Project.
4. Details for forming, including profiles, shapes, seams, and dimensions.
5. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Details of termination points and assemblies.
7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Details of roof-penetration flashing.
9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Details of special conditions.
11. Details of connections to adjoining work.
12. Formed flashing and trim at scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples: For each exposed product and for each color and texture specified, **12 inches (300 mm)** long by actual width.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

E. Samples for Verification: Actual sample of finished products for each type of exposed finish for sheet metal and other metal accessories.

1. Sheet Metal Flashing and Trim: [**Manufacturers' standard size**] . Include finished seam with required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For each type of coping and roof edge flashing that is [**ANSI/SPRI/FM 4435/ES-1 tested**][**FM Approvals approved**] .

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For copings and roof edge flashing, from [**an agency acceptable to authority having jurisdiction**][**ICC-ES**] showing compliance with ANSI/SPRI/FM 4435/ES-1.

D. Qualification Statements: For fabricator.

E. Sample Warranties: For specified special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers**] .

C. For roof edge flashings and copings that are ANSI/SPRI/FM 4435/ES-1 tested [**and FM Approvals approved**] , shop is to be listed as able to fabricate required details as tested and approved.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof [**edge**][**eave**] , including [**built-in gutter**][**fascia**][**fascia trim**][**apron flashing**], approximately [**10 ft. (3.0 m)**] long, including supporting construction cleats, seams, attachments, [**underlayment,**] and accessories.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with [**NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing"**][**SMACNA's "Architectural Sheet Metal Manual"**] requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Design Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. SPRI Wind Design Standard: Manufacture and install roof edge flashings and copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

   1. Design Pressure: [**As indicated on Drawings**] .

E. FM Approvals Listing: Manufacture and install roof edge flashings and copings that comply with requirements in FM Approvals 4471 as part of a roofing system and that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**]. Identify materials with name of fabricator and design approved by FM Approvals.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

   1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 SHEET METAL MATERIALS

A. Sheet Metal Materials, General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality.

   1. Nominal Thickness: [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**][**0.034 inch**

(0.86 mm)][0.040 inch (1.02 mm)][0.052 inch (1.32 mm)] .

2. Surface: [**Smooth, flat**][**Embossed**][**and mill phosphatized for field painting**][**and with manufacturer's standard clear acrylic coating on both sides**] .
3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    c. Mica Fluoropolymer: Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    d. Metallic Fluoropolymer: Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    e. FEVE Fluoropolymer: Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Sheet: ASTM B209/B209M, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] .
2. Surface: [**Smooth, flat**][**Embossed**] .
3. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    c. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin

manufacturers' written instructions [**for seacoast and severe environments**] .

d. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

e. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.
6. Clear Anodic Finish, Coil Coated: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
7. Color Anodic Finish, Coil Coated: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

    a. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].
    b. Color Range: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

8. As-Milled Finish: [**Mill**][**One-side bright mill**][**Standard one-side bright**][**Standard two-side bright**] .
9. Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.
10. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of **0.2 mil (0.005 mm)**.

D. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**] ; dead soft, fully annealed.

1. Nominal Thickness: [**0.0156 inch (0.396 mm)**][**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**][**0.0313 inch (0.795 mm)**][**0.0375 inch (0.952 mm)**][**0.0500 inch (1.270 mm)**] .
2. Surface: [**Smooth, flat**][**Embossed**] .
3. Exterior Finish: [**ASTM A480/A480M, No. 2B (bright, cold rolled)**][**ASTM A480/A480M, No. 2D (dull, cold rolled)**][**ASTM A480/A480M, No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4**].

    a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
    b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

        1) Run grain of directional finishes with long dimension of each piece.
        2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

E. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Hussey Copper Ltd.**]
   b. [**Revere Copper Products, Inc**]

2. Thickness: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**].
3. Nonpatinated, Exposed Finish: Mill.
4. Nonpatinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA AMP 500.

   a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.
   b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.

5. Prepatinated Copper-Sheet Finish: [**Dark brown**][**Verdigris**], prepatinated in accordance with ASTM B882.

F. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper; coated on both sides with zinc-tin alloy (50 percent zinc, 50 percent tin).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Revere Copper Products, Inc**]

2. Thickness: [**16 oz./sq. ft. (0.55 mm thick)**][**20 oz./sq. ft. (0.68 mm thick)**][**24 oz./sq. ft. (0.82 mm thick)**][**25 oz./sq. ft. (0.87 mm thick)**] .

G. Zinc Sheet: With manufacturer's standard factory-applied, flexible, protective back coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Artazn LLC**]
   b. [**Rheinzink America**]

2. Grade: [**99.995 percent electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent)**][**Zinc, 99**

percent pure, alloyed with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum] .

3. Thickness: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**][**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] .
4. Finish: [**Bright rolled**][**Preweathered gray**][**Preweathered black**].

H. Copper-Clad Stainless Steel Sheet: ASTM B506, annealed Temper O61.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Heyco Metals**]
    b. [**SEMCO Southeastern Metals, A Gibraltar Industries Company**]

2. Thickness: [**0.016 inch (0.40 mm)**][**0.018 inch (0.46 mm)**][**0.027 inch (0.69 mm)**] .
3. Nonpatinated, Exposed Finish: Mill.
4. Nonpatinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA AMP 500.

    a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.
    b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.

I. Lead Sheet: ASTM B749 lead sheet.

1. Thickness: **4 lb (1.8 kg)**.

2.3 UNDERLAYMENT

A. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over **220 deg F (111 deg C)**; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Intertape Polymer Group**]
    c. [**Kirsch Building Products**]
    d. [**SDP Advanced Polymer Products Inc.**]

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet

underlayment, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ATAS International, Inc.**]
    b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
    c. [**GCP Applied Technologies Inc.**]
    d. [**Henry; a Carlisle Company**]
    e. [**Owens Corning**]
    f. [**Polyglass U.S.A., Inc.**]
    g. [**Protecto Wrap Company**]
    h. [**SDP Advanced Polymer Products Inc.**]

2. Thickness: **30 mils (0.76 mm)** minimum.
3. Thermal Stability: Stable after testing at **240 deg F (116 deg C)**; ASTM D1970/D1970M.
4. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)** or lower; ASTM D1970/D1970M.

C. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

D. Slip Sheet: Rosin-sized building paper, **3 lb/100 sq. ft. (0.16 kg/sq. m)** minimum, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners [**solder**] , protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal [**manufactured item**] unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal [**manufactured item**] .

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
    c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
5. Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet:

Copper, hardware bronze or passivated Series 300 stainless steel.

6. Fasteners for Zinc Sheet: Series 300 stainless steel [**or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M**] .

C. Solder:

1. For Zinc-Coated (Galvanized) Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead**][**with maximum lead content of 0.2 percent**] .
2. For Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
3. For Copper or Copper-Clad Stainless Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead**][**with maximum lead content of 0.2 percent**] .
4. For Zinc-Tin Alloy-Coated Copper: ASTM B32, 100 percent tin, with maximum lead content of 0.2 percent, as recommended by sheet metal manufacturer.
5. For Zinc: ASTM B32, [**40 percent tin and 60 percent lead with low antimony,**][**with maximum lead content of 0.2 percent,**] as recommended by zinc manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.

E. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

1. Material: [**Polyurethane**][**Polysulfide**][**Silicone**] .

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

J. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated [**with factory-mitered and -welded corners and junctions**][**with interlocking counterflashing on exterior face, of same metal as reglet**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cheney Flashing Company**]
b. [**Fry Reglet Corporation**]
c. [**Heckmann Building Products, Inc.**]
d. [**Hohmann & Barnard, Inc**]
e. [**Keystone Flashing Company, Inc**]
f. [**Metal-Era, Inc.; a Carlisle Company**]
g. [**OMG Roofing Products; a Division of OMG, Inc.**]

2. Material: [**Galvanized steel, 0.022 inch (0.56 mm) thick**][**Aluminum, 0.024 inch (0.61 mm) thick**][**Stainless steel, 0.0188 inch (0.477 mm) thick**][**Copper, 16 oz./sq. ft. (0.55 mm thick)**] .
3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
5. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
7. Accessories:

    a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
    b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

8. Finish: [**Mill**][**With manufacturer's standard color coating**].

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard [**and by FM Global Property Loss Prevention Data Sheet 1-49**] for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. [**Rivet joints where necessary for strength.**]
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. [**Rivet joints where necessary for strength.**]

H. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.

1. Minimum Fabrication Length: **96-inch- (2400-mm-)** long sections.
2. Gutter Brackets, Spacers, and Straps: Furnish flat-stock gutter brackets and [**flat-stock**][**twisted**] gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than [**twice the gutter thickness**][**dimension indicated on Drawings**].
3. Gutter Components: Fabricate expansion joints, expansion-joint covers, [**gutter bead reinforcing bars,**] and gutter accessories from same metal as gutters. [**Shop fabricate interior and exterior corners.**]
4. Gutter Profile: [**Style A**][**Style B**][**Style C**][**Style D**][**Style E**][**Style F**][**Style G**][**Style H**][**Style I**][**Style J**][**Style K**][**Style L**] in accordance with cited sheet metal standard.
5. Expansion Joints: [**Lap type**][**Butt type**][**Butt type with cover plate**][**Built in**] .
6. Accessories: [**Continuous, removable leaf screen with sheet metal frame and hardware cloth screen**][**Wire-ball downspout strainer**][**Valley baffles**] .
7. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:

    a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
    c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
    d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

8. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:

    a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
    c. Aluminum: [**0.040 inch (1.02 mm)**] thick.
    d. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.039 inch (1.00 mm)**][**0.048 inch (1.25 mm)**] thick.

h. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

9. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.034 inch (0.86 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.034 inch (0.86 mm)**] thick.
c. Aluminum: [**0.050 inch (1.27 mm)**] thick.
d. Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
e. Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
g. Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

10. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
c. Aluminum: [**0.063 inch (1.60 mm)**] thick.
d. Stainless Steel: [**0.0313 inch (0.795 mm)**] thick.
e. Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].

11. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.052 inch (1.32 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.052 inch (1.32 mm)**] thick.
c. Stainless Steel: [**0.0375 inch (0.952 mm)**] thick.
d. Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**25 oz./sq. ft. (0.87 mm thick)**].

B. Built-In Gutters: Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.

1. Minimum Fabrication Length: **96-inch- (2400-mm-)** long sections.
2. Gutter Components: Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
3. Expansion Joints: Fabricate gutters with built-in expansion joints [**and gutter-end expansion joints at walls**] .
4. Accessories: [**Continuous, removable leaf screen with sheet metal frame and hardware cloth screen**][**Bronze wire-ball downspout strainer**][**Wire-ball downspout strainer**] .
5. Fabricate from the following materials:

a. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
b. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
c. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
d. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
e. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

C. Downspouts: Fabricate downspouts to dimensions indicated on Drawings.

1. Type: [**Round**][**Rectangular**][**Open face**] .
2. Downspout Elbows: Mitered [**and shop fabricated**] .
3. Metal Hangers: Provide [**same material as downspouts and anchors**].
4. Fabricated Hanger Style: [**Fig. 1-35A**][**Fig. 1-35B**][**Fig. 1-35C**][**Fig. 1-35D**][**Fig. 1-35E**][**Fig. 1-35F**][**Fig. 1-35G**][**Fig. 1-35H**][**Fig. 1-35I**][**Fig. 1-35J**] in accordance with SMACNA's "Architectural Sheet Metal Manual."

5. Manufactured Hanger Style: [**Fig. 1-34A**][**Fig. 1-34B**][**Fig. 1-34C**][**Fig. 1-34D**][**Fig. 1-34E**] in accordance with SMACNA's "Architectural Sheet Metal Manual."
6. Fabricate from the following materials:

    a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
    c. Aluminum: [**0.024 inch (0.61 mm)**] thick.
    d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

D. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, **4-inch- (100-mm-)** wide wall flanges to interior, and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof. [**Fasten gravel guard angles to base of scupper.**]

1. Fabricate from the following materials:

    a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
    c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
    d. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

E. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes [**exterior flange trim,**][**built-in overflows**] .

1. Fabricate from the following materials:

    a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
    c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
    d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

F. Splash Pans: Fabricate to dimensions and shape required.

1. Fabricate from the following materials:

    a. Aluminum: [**0.040 inch (1.02 mm)**] thick.
    b. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
    c. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    d. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    e. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    f. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2.7 SLOPED ROOF SHEET METAL FABRICATIONS

A. Low-Sloped Roof Sheet Metal Fabrications:

1. Roof Edge Flashing (Gravel Stop) and Fascia Cap:

a. Fabricate in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long sections. Furnish with **6-inch- (150-mm-)** wide, joint cover plates. [**Shop fabricate interior and exterior corners.**]
b. Joint Style: [**Overlapped, 4 inches (100 mm) wide**][**Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate**][**Butted with expansion space and 6-inch- (150-mm-) wide, exposed cover plate**].
c. Scuppers: Fabricate with scuppers spaced [**10 ft. (3 m)**] apart, to dimensions required with **4-inch- (100-mm-)** wide flanges and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
d. Fabricate from the following materials:

1) Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**] .
7) Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2. Copings:

a. Fabricate in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and [**drill elongated holes for fasteners on**] interior leg. Miter corners, [**fasten and seal**][**solder or weld**] watertight. [**Shop fabricate interior and exterior corners.**]
b. Coping Profile: [**Fig. 3-4A**][**Fig. 3-4B**][**Fig. 3-4C**][**Fig. 3-4D**][**Fig. 3-4E**][**Fig. 3-4F**][**Fig. 3-4G**] in accordance with SMACNA's "Architectural Sheet Metal Manual."
c. Joint Style: [**Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate**][**Butted with expansion space and 6-inch- (150-mm-) wide, exposed cover plate**] .
d. Fabricate from the following materials:

1) Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
5) Copper: [**24 oz./sq. ft. (0.82 mm thick)**] .
6) Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
7) Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

3. Expansion-Joint Covers:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate [**roof**][**roof-to-wall transition**][**roof-to-roof edge-flashing (gravel-stop) transition**][**roof-to-roof edge-flashing (gravel-stop) and fascia-cap transition**] expansion-joint cover from the following materials:

1) Galvanized Steel: [**0.034 inch (0.86 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.034 inch (0.86 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

4. Base Flashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3) Aluminum: [**0.040 inch (1.02 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

5. Counterflashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
3) Aluminum: [**0.032 inch (0.81 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

6. Flashing Receivers: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

7. Roof-Penetration Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
c. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
d. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].

f. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
g. Copper-Clad Stainless Steel: [0.018 inch (0.46 mm)] thick.
h. Lead: [4 lb (1.8 kg)].

8. Roof-Drain Flashing: Fabricate from the following materials:

a. Stainless Steel: [0.0156 inch (0.396 mm)] thick.
b. Copper: [12 oz./sq. ft. (0.41 mm thick)].
c. Copper-Clad Stainless Steel: [0.016 inch (0.40 mm)] thick.

B. Steep-Slope Roof Sheet Metal Fabrications:

1. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:

a. Galvanized Steel: [0.022 inch (0.56 mm)] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch (0.56 mm)] thick.
c. Aluminum: [0.032 inch (0.81 mm)] thick.
d. Stainless Steel: [0.0156 inch (0.396 mm)] thick.
e. Copper: [16 oz./sq. ft. (0.55 mm thick)].
f. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft. (0.55 mm thick)].
g. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
h. Copper-Clad Stainless Steel: [0.016 inch (0.40 mm)] thick.

2. Valley Flashing: Fabricate from the following materials:

a. Galvanized Steel: [0.028 inch (0.71 mm)] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch (0.71 mm)] thick.
c. Stainless Steel: [0.0188 inch (0.477 mm)] thick.
d. Copper: [16 oz./sq. ft. (0.55 mm thick)].
e. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft. (0.55 mm thick)].
f. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
g. Copper-Clad Stainless Steel: [0.018 inch (0.46 mm)] thick.

3. Drip Edges: Fabricate from the following materials:

a. Galvanized Steel: [0.022 inch (0.56 mm)] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch (0.56 mm)] thick.
c. Aluminum: [0.032 inch (0.81 mm)] thick.
d. Stainless Steel: [0.0156 inch (0.396 mm)] thick.
e. Copper: [16 oz./sq. ft. (0.55 mm thick)].
f. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft. (0.55 mm thick)].
g. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
h. Copper-Clad Stainless Steel: [0.016 inch (0.40 mm)] thick.

4. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:

a. Galvanized Steel: [0.022 inch (0.56 mm)] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch (0.56 mm)] thick.
c. Aluminum: [0.032 inch (0.81 mm)] thick.
d. Stainless Steel: [0.0156 inch (0.396 mm)] thick.
e. Copper: [16 oz./sq. ft. (0.55 mm thick)].
f. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft. (0.55 mm thick)].
g. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
h. Copper-Clad Stainless Steel: [0.016 inch (0.40 mm)] thick.

5. Counterflashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
3) Aluminum: [**0.032 inch (0.81 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

6. Flashing Receivers: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

7. Roof-Penetration Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
c. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
d. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
g. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.
h. Lead: [**4 lb (1.8 kg)**].

2.8 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing:

1. General: Fabricate continuous flashings in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend **6 inches (150 mm)** beyond each side of wall openings; and form with **2-inch- (50-mm-)** high, end dams. Fabricate from the following materials:

a. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
b. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
c. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
d. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
e. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

B. Opening Flashings in Frame Construction:

1. General: Fabricate head, sill, [**jamb,**] and similar flashings to extend [**4 inches (100 mm)**] beyond wall openings. Form head and sill flashing with **2-inch- (50-mm-)** high, end dams.

Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

C. Wall Expansion-Joint Cover: Fabricate from the following materials:

1. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3. Aluminum: [**0.040 inch (1.02 mm)**] thick.
4. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
7. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
4. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
5. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
6. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
3. Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
4. Copper: [**24 oz./sq. ft. (0.82 mm thick)**] .
5. Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
6. Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than **4 inches (100 mm)**.
2. Lap end joints not less than **12 inches (300 mm)**.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than **2 inches (50 mm)**.

D. Slip Sheet: Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than **4 inches (100 mm)**.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners [**solder**] , protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of [**solder**][**welds**][**sealant**] .
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than **12 inches (300 mm)** o.c.
6. Space individual cleats not more than **12 inches (300 mm)** apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.

8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of [**uncoated-aluminum**][**stainless steel**] sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of [**10 ft. (3 m)**] with no joints within **24 inches (600 mm)** of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws**][**substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance**].

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than **1 inch (25 mm)** into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below **40 deg F (4 deg C)**.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pretin edges of sheets with solder to width of **1-1/2 inches (38 mm)**; however, reduce pretinning where pretinned surface would show in completed Work.
2. Do not solder [**metallic-coated steel**][**aluminum**] sheet.
3. Do not pretin zinc-tin alloy-coated copper.
4. Do not use torches for soldering.
5. Heat surfaces to receive solder, and flow solder into joint.

a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

6. Stainless Steel Soldering:

    a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
    b. Promptly remove acid-flux residue from metal after tinning and soldering.
    c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.

H. Rivets: Rivet joints in [**uncoated aluminum**][**zinc**] where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:

1. Join sections with [**riveted and soldered joints**][**joints sealed with sealant**] .
2. Provide for thermal expansion.
3. Attach gutters at eave or fascia to firmly anchor them in position.
4. Provide end closures and seal watertight with sealant.
5. Slope to downspouts.
6. Fasten gutter spacers to front and back of gutter.
7. Anchor and loosely lock back edge of gutter to continuous [**cleat**][**eave or apron flashing**] .
8. Anchor back of gutter that extends onto roof deck with cleats spaced not more than [**24 inches (600 mm)**] apart.
9. Anchor gutter with [**gutter brackets**][**straps**][**twisted straps**] spaced not more than [**24 inches (600 mm)**][**30 inches (760 mm)**][**36 inches (910 mm)**] apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
10. Anchor gutter with spikes and ferrules spaced not more than [**24 inches (600 mm)**][**30 inches (760 mm)**] apart.
11. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, [**50 ft. (15.2 m)**] apart. Install expansion-joint caps.
12. Install continuous gutter screens on gutters with noncorrosive fasteners, [**removable**][**hinged to swing open**] for cleaning gutters.

C. Built-In Gutters:

1. Join sections with [**riveted and soldered joints**][**joints sealed with sealant**] .
2. Provide for thermal expansion.
3. Slope to downspouts.
4. Provide end closures and seal watertight with sealant.
5. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and under underlayment on roof sheathing.

    a. Lap sides minimum of **2 inches (50 mm)** over underlying course.
    b. Lap ends minimum of **4 inches (100 mm)**.
    c. Stagger end laps between succeeding courses at least **72 inches (1830 mm)**.
    d. Fasten with roofing nails.
    e. Install slip sheet over underlayment.

6. Anchor and loosely lock back edge of gutter to continuous [**cleat**][**eave or apron flashing**].
7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than [**18 inches (460 mm)**] apart.
8. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, [**50 ft. (15.2 m)**] apart. Install expansion-joint caps.

D. Downspouts:

1. Join sections with **1-1/2-inch (38-mm)** telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately **60 inches (1500 mm)** o.c.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

E. Parapet Scuppers:

1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
2. Anchor scupper closure trim flange to exterior wall and [**solder**][**seal with elastomeric sealant**] to scupper.
3. Loosely lock front edge of scupper with conductor head.
4. [**Solder**][**seal with elastomeric sealant**] exterior wall scupper flanges into back of conductor head.

F. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of **1 inch (25 mm)** below [**scupper**][**gutter**] discharge.

G. Splash Pans:

1. Install where downspouts discharge on [**low-slope roofs**].
2. Set in [**asphalt roofing cement**][**elastomeric sealant**] compatible with the substrate.

H. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of **4 inches (100 mm)** in direction of water flow.

3.5 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

A. Install sheet metal flashing and trim to comply with performance requirements [**sheet metal manufacturer's written installation instructions,**] and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at [**staggered 3-inch (75-mm)**] centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Install copings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.

    a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at [**24-inch (600-mm)**][**16-inch (400-mm)**] centers.
    b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at [**24-inch (600-mm)**] centers.

3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of **4 inches (100 mm)** over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing **4 inches (100 mm)** over base flashing.
3. Lap counterflashing joints minimum of **4 inches (100 mm)**.
4. Secure in waterproof manner by means of [**snap-in installation and sealant or lead wedges and sealant**][**interlocking folded seam or blind rivets and sealant**][**anchor and washer spaced at 12 inches (300 mm) o.c. along perimeter and 6 inches (150 mm) o.c. at corners areas**] unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with [**elastomeric**][**butyl**] sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL SHEET METAL FABRICATIONS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, [**jamb,**] and similar flashings to extend [**4 inches (100 mm)**] beyond wall openings.

C. Reglets: Installation of reglets is specified in [**Section 033000 "Cast-in-Place Concrete."**][**Section 042000 "Unit Masonry."**]

3.7 INSTALLATION OF MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing:

1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
2. Weld or seal flashing with elastomeric sealant to equipment support member.

B. Overhead-Piping Safety Pans:

1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

A. Shim and align sheet metal flashing and trim within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

A. Clean and neutralize flux materials. Clean off excess solder.

B. Clean off excess sealants.

3.10 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as directed by the Owner.

END OF SECTION 07 62 00 00

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Task	Specification	Specification Description
07 62 13 00	07 62 00 00	Sheet Metal Flashing And Trim
07 62 19 00	07 62 00 00	Sheet Metal Flashing And Trim

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SECTION 07 63 00 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes:

1. Motors.
2. Sleeves without waterstop.
3. Sleeves with waterstop.
4. Stack-sleeve fittings.
5. Sleeve-seal systems.
6. Grout.
7. Silicone sealants.
8. Escutcheons.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the fire-suppression equipment Sections.

a. Include construction details, material descriptions, and dimensions of components.
b. Include operating characteristics and furnished accessories.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft. (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Multispeed Motors, Multiple Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**].
10. Code Letter Designation:

    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes [**324T**] and larger; rolled steel for motor frame sizes smaller than [**324T**].

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box,

suited to control method.

2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [120 V][240 V] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [Circuit board][digital speed controller/LED display].
4. Building Automation System Interface: Via [AC voltage signal][DC voltage signal][Digital Serial Interface (DSI)].

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge (0.6 mm)** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Products & Systems, LLC**]
    b. [**CALPICO, Inc.**]
    c. [**GPT; a division of EnPRO Industries**]
    d. [**Metraflex Company (The)**]

2. Description: Manufactured [**PVC/HDPE**][**steel**][**stainless steel**][**galvanized steel**], sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Wade; a subsidiary of McWane Inc.**]
    c. [**Zurn Industries, LLC**]

2. Description: Manufactured, [**Dura-coated or Duco-coated**][**galvanized**] cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Products & Systems, LLC**]
    b. [**CALPICO, Inc.**]
    c. [**GPT; a division of EnPRO Industries**]
    d. [**Metraflex Company (The)**]
    e. [**Proco Products, Inc**]

2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

    a. Hydrostatic Seal: **20 psig (137 kPa)** minimum.
    b. Sealing Elements: [**EPDM-rubber**][**High-temperature-silicone**][**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
    c. Pressure Plates: [**Carbon steel**][**Composite plastic**][**Stainless steel**][**Stainless steel, Type 316**].
    d. Connecting Bolts and Nuts: [**Carbon steel, with ASTM B633 coating**][**Stainless steel**][**Stainless steel, Type 316,**] of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**ITW Polymers Sealants North America**]
      3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      4) [**Sherwin-Williams Company (The)**]
      5) [**Sika Corporation**]
      6) [**The Dow Chemical Company**]
      7) [**Tremco Incorporated**]

   b. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, [**25**][**100/50**], pourable, [**plus 25 percent and minus 25 percent**][**plus 100 percent and minus 50 percent**] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Pecora Corporation**]
      2) [**Sika Corporation**]
      3) [**The Dow Chemical Company**]
      4) [**Tremco Incorporated**]

   b. Standard: ASTM C920, Type S, Grade P, [**Class 25**][**Class 100/50**], Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Smooth-On**]

4. Sealant shall have a VOC content of [**250**] g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.3 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]

B. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**][**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**][**and**][**exposed-rivet**] hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.2 INSTALLATION OF SLEEVES, GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch (25-mm)**][**2-inch (50-mm)**] annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches (50 mm)**] above finished floor level.

3. Using [grout][silicone sealant], seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire-resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width centered in concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [grout][silicone sealant], seal space around outside of sleeves.

3.4 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to **3 inches (75 mm)** above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.6 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.7 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.8 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**] annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**] annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [Sleeves with waterstops][stack-sleeve fittings].

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.9 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece[steel][cast brass][or split plate steel] with polished, chrome-plated finish.
3. Insulated Piping:

a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

a. One piece, steel with polished, chrome-plated finish.
b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

a. One piece, steel with polished, chrome-plated finish.
b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

END OF SECTION 07 63 00 00

SECTION 07 63 00 00A - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Packed expansion joints.
3. Packless expansion joints.
4. Grooved-joint expansion joints.
5. Alignment guides and anchors.
6. Sleeves without waterstop.
7. Sleeves with waterstop.
8. Stack-sleeve fittings.
9. Sleeve-seal systems.
10. Grout.
11. Silicone sealants.
12. Escutcheons.
13. Thermometers, bimetallic actuated.
14. Thermometers, filled system.
15. Thermometers, liquid in glass.
16. Thermometers, light activated.
17. Duct-thermometer mounting brackets.
18. Thermowells.
19. Pressure gauges, dial type.
20. Gauge attachments.
21. Test plugs.
22. Test-plug kits.
23. Sight flow indicators.
24. Flowmeters.
25. Thermal-energy meters.

B. Related Requirements:

1. Section 231123 "Facility Natural-Gas Piping" for gas meters.
2. Section 232216 "Steam and Condensate Piping Specialties" for steam and condensate meters.
3. Section 230923.13 "Energy Meters" for thermal-energy meters connecting with the DDC system.
4. Section 230923.14 "Flow Instruments" for primary flow instruments connecting with the DDC system.

1.2 DEFINITIONS

A. Existing Piping To Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.

    a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
    b. Include operating characteristics and furnished accessories.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter.

B. Welding certificates.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of [**expansion joint,**][**meter,**][**and**][**gauge**] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.7 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft. (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**]<**Insert class**>.
10. Code Letter Designation:
    a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.
11. Enclosure Material: Cast iron for motor frame sizes [**324T**]<**Insert number**> and larger; rolled steel for motor frame sizes smaller than [**324T**]<**Insert number**>.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [**120 V**][**or**][**240 V**] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [**Circuit board**][**or**][**digital speed controller/LED display**].
4. Building Automation System Interface: Via [**AC voltage signal**][**DC voltage signal**][**or**][**Digital Serial Interface (DSI)**].

2.2 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Packed Expansion Joints:

1. Flexible, Ball-Joint Packed Expansion Joints: [**FBJ-01**]<**Insert drawing designation**>.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Advanced Thermal Systems, Inc**]
2) [**Hyspan Precision Products, Inc**]
3) [**Mason Industries, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Thermal Systems, Inc**]
2) [**Hyspan Precision Products, Inc**]
3) [**Mason Industries, Inc.**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
d. Standards: 2021 ASME Boiler and Pressure Vessel Code: Section II, "Materials"; ASME B31.9 for materials and design of pressure-containing parts and bolting.
e. Material: Carbon-steel assembly with asbestos-free composition packing.
f. Design: Provide 360-degree rotation and angular deflection.
g. Minimum Pressure Rating: [**250 psig at 400 deg F (1725 kPa at 204 deg C)**]<**Insert value**>.
h. Angular Deflection for NPS 6 (DN 150) and Smaller: 30 degrees minimum.
i. Angular Deflection for NPS 8 (DN 200) and Larger: 15 degrees minimum.
j. Seal Type: Two carbon-steel and graphite seals suitable for continuous operation at temperature up to **650 deg F (343 deg C)**.
k. Internal Ball: Plated with minimum 1-mil chrome cover.
l. Ball Socket: One- or two-piece design with integral socket/retainer.

1) Stuffing Box: Incorporates containment seals and compression seals for containment of injectable packing.
2) Packing Cylinders: Provides packing under full line pressure with check valves to prevent blowback.

m. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
n. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2. Slip-Joint Packed Expansion Joints: [**SJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Advanced Thermal Systems, Inc**]
3) [**Hyspan Precision Products, Inc**]
4) [**Metraflex Company (The)**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of

the following:

1) [**Adsco Manufacturing LLC**]
2) [**Advanced Thermal Systems, Inc**]
3) [**Hyspan Precision Products, Inc**]
4) [**Metraflex Company (The)**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain slip-joint packed expansion joints from single manufacturer.
d. Standard: ASTM F1007.
e. Material: Carbon steel with asbestos-free PTFE packing.
f. Design: With internal guide and injection ports for repacking under full system pressure. Housing is to be furnished with drain ports and lifting ring. Include drip connection if used for steam piping.
g. Configuration: [**Single joint**][**single joint with base**][**and**][**double joint with base**] class(es) unless otherwise indicated.
h. Slip Tube for Sizes NPS 1-1/2 (DN 40) through NPS 16 (DN 400): Schedule 80.
i. Slip Tube for Sizes NPS 18 (DN 450) through NPS 24 (DN 600): Schedule 60.
j. Sliding Surface: 2-mil-thick chrome finish.
k. End Connections: Flanged or welded ends to match piping system.

C. Packless Expansion Joints:

1. Metal, Compensator Packless Expansion Joints: [**MCEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Flex-Hose Co., Inc**]
2) [**Flex-Weld Inc., div of Kelco Industries**]
3) [**Flex-Weld; a division of Kelco**]
4) [**Flexicraft Industries**]
5) [**Hyspan Precision Products, Inc**]
6) [**Metraflex Company (The)**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Flex-Hose Co., Inc**]
2) [**Flex-Weld Inc., div of Kelco Industries**]
3) [**Flex-Weld; a division of Kelco**]
4) [**Flexicraft Industries**]
5) [**Hyspan Precision Products, Inc**]
6) [**Metraflex Company (The)**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain metal compensator packless expansion joints from single manufacturer.
d. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> unless otherwise indicated.
e. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid

flow by an internal pipe sleeve and external housing.

f. Joint Axial Movement: **2 inches (50 mm)** of compression and **1/2 inch (12 mm)** of extension.

g. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.

1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: [**Solder joint**][**or**][**threaded**].
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.

h. Configuration for Steel Piping: Multi-ply, stainless steel bellows; steel-pipe end connections; and carbon-steel shroud.

1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Flanged**][**Threaded**][**Welded**].

2. Rubber Union Connector Expansion Joints: [**RUEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flo Fab Inc**]
4) [**General Rubber Corporation**]
5) [**Kadant Unaflex, LLC**]
6) [**Metraflex Company (The)**]
7) [**Proco Products, Inc**]
8) [**Unisource Manufacturing, Inc.**]
9) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flo Fab Inc**]
4) [**General Rubber Corporation**]
5) [**Kadant Unaflex, LLC**]
6) [**Metraflex Company (The)**]
7) [**Proco Products, Inc**]
8) [**Unisource Manufacturing, Inc.**]
9) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.

d. Material: Twin reinforced-rubber spheres[**with external restraining cables**].

e. Minimum Pressure Rating: [**150 psig at 170 deg F (1035 kPa at 77 deg C)**]<**Insert value**> unless otherwise indicated.

f. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

g. End Connections for Greater than NPS 2 (DN 50): Flanged.

3. Flexible-Hose Packless Expansion Joints: [**FHEJ-01**]<**Insert drawing designation**>.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**ASC Engineered Solutions**]
      2) [**Flex-Hose Co., Inc**]
      3) [**Flex-Pression**]
      4) [**Flex-Weld Inc., div of Kelco Industries**]
      5) [**Flex-Weld; a division of Kelco**]
      6) [**Flexicraft Industries**]
      7) [**Kadant Unaflex, LLC**]
      8) [**Metraflex Company (The)**]
      9) [**Proco Products, Inc**]
      10) [**Unisource Manufacturing, Inc.**]
      11) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**ASC Engineered Solutions**]
      2) [**Flex-Hose Co., Inc**]
      3) [**Flex-Pression**]
      4) [**Flex-Weld Inc., div of Kelco Industries**]
      5) [**Flex-Weld; a division of Kelco**]
      6) [**Flexicraft Industries**]
      7) [**Kadant Unaflex, LLC**]
      8) [**Metraflex Company (The)**]
      9) [**Proco Products, Inc**]
      10) [**Unisource Manufacturing, Inc.**]
      11) <**Insert manufacturer's name**>

   c. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.

   d. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

   e. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

   f. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with [**solder-joint**]<**Insert type**> end connections.

      1) Bronze hoses and single-braid bronze sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **340 psig at 450 deg F (2340 kPa at 232 deg C)** ratings.
      2) Bronze hoses and double-braid bronze sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **500 psig at 450 deg F (3450 kPa at 232 deg C)** ratings.

   g. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with [**threaded**]<**Insert type**> end connections.

      1) Stainless steel hoses and single-braid, stainless steel sheaths with

300 psig at 70 deg F (2070 kPa at 21 deg C) and **225 psig at 450 deg F (1550 kPa at 232 deg C)** ratings.

2) Stainless steel hoses and double-braid, stainless steel sheaths with **420 psig at 70 deg F (2890 kPa at 21 deg C)** and **315 psig at 450 deg F (2170 kPa at 232 deg C)** ratings.

h. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **325 psig at 600 deg F (2250 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **515 psig at 600 deg F (3550 kPa at 315 deg C)** ratings.

i. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon-steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **200 psig at 70 deg F (1380 kPa at 21 deg C)** and **145 psig at 600 deg F (1000 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **275 psig at 70 deg F (1900 kPa at 21 deg C)** and **200 psig at 600 deg F (1380 kPa at 315 deg C)** ratings.

j. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Carbon steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **125 psig at 70 deg F (860 kPa at 21 deg C)** and **90 psig at 600 deg F (625 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **165 psig at 70 deg F (1130 kPa at 21 deg C)** and **120 psig at 600 deg F (830 kPa at 315 deg C)** ratings.

k. Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon-steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and double-braid, stainless steel sheaths with **165 psig at 70 deg F (1130 kPa at 21 deg C)** and **120 psig at 600 deg F (830 kPa at 315 deg C)** ratings.

4. Metal-Bellows Packless Expansion Joints: [**MBEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Badger Industries, Inc**]
3) [**Flex-Hose Co., Inc**]
4) [**Flex-Pression**]
5) [**Flex-Weld Inc., div of Kelco Industries**]
6) [**Flex-Weld; a division of Kelco**]

7) [**Flexicraft Industries**]
8) [**Flo Fab Inc**]
9) [**Hyspan Precision Products, Inc**]
10) [**Kadant Unaflex, LLC**]
11) [**Metraflex Company (The)**]
12) [**Proco Products, Inc**]
13) [**Senior Flexonics Pathway**]
14) [**Tozen Corporation**]
15) [**U.S. Bellows, Inc.**]
16) [**Unisource Manufacturing, Inc.**]
17) [**Universal Hose and Braid; a Hyspan Company**]
18) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Adsco Manufacturing LLC**]
2) [**Badger Industries, Inc**]
3) [**Flex-Hose Co., Inc**]
4) [**Flex-Pression**]
5) [**Flex-Weld Inc., div of Kelco Industries**]
6) [**Flex-Weld; a division of Kelco**]
7) [**Flexicraft Industries**]
8) [**Flo Fab Inc**]
9) [**Hyspan Precision Products, Inc**]
10) [**Kadant Unaflex, LLC**]
11) [**Metraflex Company (The)**]
12) [**Proco Products, Inc**]
13) [**Senior Flexonics Pathway**]
14) [**Tozen Corporation**]
15) [**U.S. Bellows, Inc.**]
16) [**Unisource Manufacturing, Inc.**]
17) [**Universal Hose and Braid; a Hyspan Company**]
18) <**Insert manufacturer's name**>

c. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
d. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
e. Type: Circular, corrugated bellows[**with external tie rods**].
f. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**200 psig (1379 kPa)**]<**Insert value**> unless otherwise indicated.
g. Configuration: [**Single joint**][**Single joint with base**][**and**][**double joint with base**] class(es), unless otherwise indicated.
h. Expansion Joints for Copper Tubing: [**Single-**][**or**][**multi-**]ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: [**Solder joint**][**or**][**threaded**].
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Solder joint**][**or**][**threaded**].
3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.

i. Expansion Joints for Steel Piping: [**Single-**][**or**][**multi-**]ply stainless steel bellows, steel pipe

ends, and carbon steel shroud.

1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 (DN 65) and Larger: [**Flanged**][**Welded**].

5. Externally Pressurized Metal-Bellows Packless Expansion Joints: [**EPEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld Inc., div of Kelco Industries**]
5) [**Flex-Weld; a division of Kelco**]
6) [**Flexicraft Industries**]
7) [**Hyspan Precision Products, Inc**]
8) [**Metraflex Company (The)**]
9) [**Senior Flexonics Pathway**]
10) [**Tozen Corporation**]
11) [**U.S. Bellows, Inc.**]
12) [**Unisource Manufacturing, Inc.**]
13) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Adsco Manufacturing LLC**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld Inc., div of Kelco Industries**]
5) [**Flex-Weld; a division of Kelco**]
6) [**Flexicraft Industries**]
7) [**Hyspan Precision Products, Inc**]
8) [**Metraflex Company (The)**]
9) [**Senior Flexonics Pathway**]
10) [**Tozen Corporation**]
11) [**U.S. Bellows, Inc.**]
12) [**Unisource Manufacturing, Inc.**]
13) <**Insert manufacturer's name**>

c. Source Limitations: Obtain externally pressurized metal-bellows packless expansion joints from single manufacturer.
d. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1379 kPa)**][**300 psig (2068 kPa)**]<**Insert value**> unless otherwise indicated.
e. Description:

1) Totally enclosed, externally pressurized, multi-ply, stainless steel bellows isolated from fluid flow by an internal pipe sleeve.
2) Carbon-steel housing.
3) Drain plugs and lifting lug for **NPS 3 (DN 80)** and larger.
4) Bellows: With operating clearance between internal pipe sleeves and external

shrouds.

5) Joints: Supplied with a built-in scale to confirm the starting position and operating movement.

6) Joint Axial Movement: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**]<**Insert compression limit**> of compression and [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert extension limit**> of extension.

f. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are unacceptable.

g. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

6. Rubber Packless Expansion Joints: [**REJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Weld Inc., div of Kelco Industries**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Garlock Sealing Technologies**]
7) [**General Rubber Corporation**]
8) [**Kadant Unaflex, LLC**]
9) [**Metraflex Company (The)**]
10) [**Proco Products, Inc**]
11) [**Red Valve Company, Inc**]
12) [**Tozen Corporation**]
13) [**U.S. Bellows, Inc.**]
14) [**Unisource Manufacturing, Inc.**]
15) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Weld Inc., div of Kelco Industries**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Garlock Sealing Technologies**]
7) [**General Rubber Corporation**]
8) [**Kadant Unaflex, LLC**]
9) [**Metraflex Company (The)**]
10) [**Proco Products, Inc**]
11) [**Red Valve Company, Inc**]
12) [**Tozen Corporation**]
13) [**U.S. Bellows, Inc.**]
14) [**Unisource Manufacturing, Inc.**]
15) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber packless expansion joints from single manufacturer.
d. Standards: ASTM F1123 and FSA's "Expansion Joints - Piping Technical Handbook."
e. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
f. Arch Type: [**Single**][**or**][**multiple**] arches[**with external control rods**].
g. Spherical Type: [**Single**][**or**][**multiple**] spheres[**with external control rods**].
h. Minimum Pressure Rating for NPS 1-1/2 to NPS 12 (DN 40 to DN 300): [**225 psig (1551 kPa) at 170 deg F (77 deg C)**]<**Insert pressure and temperature values**>.
i. Material for Fluids Containing Acids, Alkalis, or Chemicals: [**Butyl rubber**][**Chlorosulfonyl-polyethylene rubber**][**EPDM rubber**]<**Insert material**>.
j. Material for Fluids Containing Gas, Hydrocarbons, or Oil: [**Buna-N**][**Chlorosulfonated polyethylene synthetic rubber**]<**Insert material**>.
k. Material for Water: [**Butyl rubber**][**Buna-N**][**Chlorosulfonated polyethylene synthetic rubber**][**Chlorosulfonyl-polyethylene rubber**][**EPDM rubber**][**Natural rubber**].
l. End Connections: Full-faced, integral steel flanges with steel retaining rings.

D. Grooved-Joint Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASC Engineered Solutions**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASC Engineered Solutions**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain grooved-joint expansion joints from single manufacturer.
4. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
5. Standard: AWWA C606, for grooved joints.
6. Materials: [**Galvanized,**]ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.
7. Couplings: [**Five**][**Seven**][**10**][**12**]<**Insert number**>, flexible type for steel-pipe dimensions. Include ferrous housing sections [**, Buna-N gasket,**][**, EPDM rubber gasket,**] and bolts and nuts.

E. Alignment Guides and Anchors:

1. Alignment Guides: [**AG-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Thermal Systems, Inc**]
2) [**Amber/Booth Company, Inc.; a VMC Group Company**]

3) [**ASC Engineered Solutions**]
4) [**Flex-Hose Co., Inc**]
5) [**Flex-Pression**]
6) [**Flex-Weld Inc., div of Kelco Industries**]
7) [**Flex-Weld; a division of Kelco**]
8) [**Flexicraft Industries**]
9) [**Hyspan Precision Products, Inc**]
10) [**Metraflex Company (The)**]
11) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Thermal Systems, Inc**]
2) [**Amber/Booth Company, Inc.; a VMC Group Company**]
3) [**ASC Engineered Solutions**]
4) [**Flex-Hose Co., Inc**]
5) [**Flex-Pression**]
6) [**Flex-Weld Inc., div of Kelco Industries**]
7) [**Flex-Weld; a division of Kelco**]
8) [**Flexicraft Industries**]
9) [**Hyspan Precision Products, Inc**]
10) [**Metraflex Company (The)**]
11) <**Insert manufacturer's name**>

c. Source Limitations: Obtain alignment guides from single manufacturer.
d. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.

2. Anchor Materials:

a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, [**zinc-coated carbon**][**stainless**] steel.
2) Expansion Plug: [**Zinc-coated carbon**][**Stainless**] steel.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, [**zinc-coated carbon**][**stainless**] steel with continuous thread on stud, unless otherwise indicated.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

2.3 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge (0.6 mm)** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GPT; a division of EnPRO Industries**]
   d. [**Metraflex Company (The)**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GPT; a division of EnPRO Industries**]
   d. [**Metraflex Company (The)**]
   e. <**Insert manufacturer's name**>

3. Description: Manufactured [**PVC/HDPE**][**steel**][**stainless steel**][**galvanized-steel**], sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Wade; a subsidiary of McWane Inc.**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Wade; a subsidiary of McWane Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Description: Manufactured, [**Dura-coated or Duco-coated**][**galvanized**] cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**Airex Manufacturing Inc.**]
c. [**CALPICO, Inc.**]
d. [**GPT; a division of EnPRO Industries**]
e. [**Metraflex Company (The)**]
f. [**Proco Products, Inc**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**Airex Manufacturing Inc.**]
c. [**CALPICO, Inc.**]
d. [**GPT; a division of EnPRO Industries**]
e. [**Metraflex Company (The)**]
f. [**Proco Products, Inc**]
g. <**Insert manufacturer's name**>

3. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

a. Hydrostatic seal: **20 psig (137 kPa) minimum)**.
b. Sealing Elements: [**EPDM-rubber**][**High-temperature-silicone**][**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
c. Pressure Plates: [**Carbon steel**][**Composite plastic**][**Stainless steel**][**Stainless steel, Type 316**].
d. Connecting Bolts and Nuts: [**Carbon steel, with zinc coating. ASTM B633**][**Stainless steel**][**Stainless steel, Type 316,**] of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-

cement grout.

3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**ITW Polymers Sealants North America**]
      3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      4) [**Sherwin-Williams Company (The)**]
      5) [**Sika Corporation**]
      6) [**The Dow Chemical Company**]
      7) [**Tremco Incorporated**]
      8) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**ITW Polymers Sealants North America**]
      3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      4) [**Sherwin-Williams Company (The)**]
      5) [**Sika Corporation**]
      6) [**The Dow Chemical Company**]
      7) [**Tremco Incorporated**]
      8) <**Insert manufacturer's name**>

   c. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, [**25**][**100/50**], pourable, [**plus 25 percent and minus 25 percent**][**plus 100 percent and minus 50 percent**] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Pecora Corporation**]
      2) [**Sika Corporation**]
      3) [**The Dow Chemical Company**]
      4) [**Tremco Incorporated**]
      5) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Pecora Corporation**]
2) [**Sika Corporation**]
3) [**The Dow Chemical Company**]
4) [**Tremco Incorporated**]
5) <**Insert manufacturer's name**>

c. Standard: ASTM C920, Type S, Grade P, [**Class 25**][**Class 100/50**], Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Smooth-On**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Smooth-On**]
2) <**Insert manufacturer's name**>

4. Sealant shall have a VOC content of [**250**]<**Insert value**> g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.4 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BrassCraft Manufacturing Co.; a Masco company**]

2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7. <**Insert manufacturer's name**>

C. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**][**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**][**and**][**exposed-rivet**] hinge; and spring-clip fasteners.

D. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

2.5 METERS AND GAUGES FOR HVAC PIPING

A. Thermometers, Bimetallic Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Blue Ribbon Corp.**]
c. [**Ernst Flow Industries**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**WATTS; A Watts Water Technologies Company**]

l. [**Weiss Instruments, Inc**]
m. [**Weksler Glass Thermometer Corp.**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Blue Ribbon Corp.**]
c. [**Ernst Flow Industries**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**WATTS; A Watts Water Technologies Company**]
l. [**Weiss Instruments, Inc**]
m. [**Weksler Glass Thermometer Corp.**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Provide bimetallic-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Liquid-filled**][**and**][**sealed**] type(s); stainless steel with [**3-inch (75-mm)**][**5-inch (125-mm)**]<**Insert dimension**> nominal diameter.
6. Dial: [**Nonreflective aluminum**]<**Insert material**> with permanently etched scale markings and scales in [**deg F (deg C)**][**deg F and deg C**].
7. Connector Type(s): Union joint, [**adjustable angle**][**rigid, back**][**and**][**rigid, bottom**]<**Insert type**>, with unified-inch screw threads.
8. Connector Size: [**1/2 inch (12 mm)**]<**Insert dimension**>, with ASME B1.1 screw threads.
9. Stem: **0.25 or 0.375 inch (6.4 or 9.5 mm)** in diameter; stainless steel.
10. Window: [**Plain glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: Stainless steel.
12. Element: Bimetal coil.
13. Pointer: Dark-colored metal.
14. Accuracy: Plus or minus [**1**][**1.5**]<**Insert number**> percent of scale range.

B. Thermometers, Filled System - Direct-Mounted, Metal-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**REOTEMP Instrument Corporation**]

f. [**Trerice, H. O. Co**]
g. [**Weiss Instruments, Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**REOTEMP Instrument Corporation**]
f. [**Trerice, H. O. Co**]
g. [**Weiss Instruments, Inc**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, direct-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical,[**dampening type,**] with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
12. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

C. Thermometers, Filled System - Direct-Mounted, Plastic-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Miljoco Corporation**]
c. [**REOTEMP Instrument Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Miljoco Corporation**]
c. [**REOTEMP Instrument Corporation**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, direct-mounted, plastic-case, vapor-actuated thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**or**][**plastic**]<**Insert material**>.
12. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

D. Thermometers, Filled-System - Remote-Mounted, Metal-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Marsh Bellofram**]
    e. [**Miljoco Corporation**]
    f. [**Palmer Wahl Instrumentation Group**]
    g. [**REOTEMP Instrument Corporation**]
    h. [**Trerice, H. O. Co**]
    i. [**Weiss Instruments, Inc**]
    j. [**WIKA Instrument Corporation**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Marsh Bellofram**]

e. [**Miljoco Corporation**]
f. [**Palmer Wahl Instrumentation Group**]
g. [**REOTEMP Instrument Corporation**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, remote-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
12. Connector Type(s): Union joint, [**back**][**bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

E. Thermometers, Filled System - Remote-Mounted, Plastic-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Miljoco Corporation**]
    d. [**REOTEMP Instrument Corporation**]
    e. [**Trerice, H. O. Co**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Miljoco Corporation**]
    d. [**REOTEMP Instrument Corporation**]
    e. [**Trerice, H. O. Co**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, remote-mounted, plastic-case, vapor-actuated

thermometers from a single manufacturer.

4. Standard: ASME B40.200.
5. Case: Sealed type, [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**or**][**plastic**]<**Insert material**>.
12. Connector Type(s): Union joint, threaded, [**back**][**bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

F. Thermometers, Liquid-in-Glass - Metal Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, metal-case, compact-style thermometers by single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Cast aluminum**]<**Insert material**>; **6-inch (150-mm)** nominal size.
6. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: Glass or plastic.
10. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Connector: **3/4 inch (19 mm)**, with ASME B1.1 screw threads.

12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

G. Thermometers, Liquid in Glass - Plastic Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Flo Fab Inc**]
    c. [**Miljoco Corporation**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Weiss Instruments, Inc**]
    f. [**Weksler Glass Thermometer Corp.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Blue Ribbon Corp.**]
    b. [**Flo Fab Inc**]
    c. [**Miljoco Corporation**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Weiss Instruments, Inc**]
    f. [**Weksler Glass Thermometer Corp.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, plastic-case, compact-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Plastic**]<**Insert material**>; **6-inch (150-mm)** nominal size.
6. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: Glass or plastic.
10. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Connector: **3/4 inch (19 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

H. Thermometers, Liquid in Glass - Metal Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]

b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**Trerice, H. O. Co**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Ribbon Corp.**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**Trerice, H. O. Co**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, metal-case, industrial-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Cast aluminum**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
6. Case Form: [**Adjustable angle**][**Back angle**][**Straight**]<**Insert form**> unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
10. Stem: [**Aluminum**]<**Insert material**> and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

11. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

I. Thermometers, Liquid in Glass - Plastic Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ernst Flow Industries**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Weiss Instruments, Inc**]

g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ernst Flow Industries**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, plastic-case, industrial-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Plastic**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
6. Case Form: [**Adjustable angle**][**Back angle**][**Straight**]<**Insert form**> unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
10. Stem: [**Aluminum**][**Brass**][**Stainless steel**][**Aluminum, brass, or stainless steel**]<**Insert material**> and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

11. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

J. Thermometers, Light Activated - Direct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Miljoco Corporation**]
b. [**Trerice, H. O. Co**]
c. [**Weiss Instruments, Inc**]
d. [**Weksler Glass Thermometer Corp.**]
e. [**Winters Instruments - U.S.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Miljoco Corporation**]
b. [**Trerice, H. O. Co**]
c. [**Weiss Instruments, Inc**]
d. [**Weksler Glass Thermometer Corp.**]
e. [**Winters Instruments - U.S.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Provide light-activated, direct-mounted thermometers from single manufacturer.
4. Case: [**Plastic**][**Metal**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
5. Scale(s): [**Deg F (deg C)**][**Deg F and deg C**].
6. Case Form: [**Adjustable angle**]<**Insert form**>.
7. Connector: [**1-1/4 inches (32 mm)**]<**Insert dimension**>, with ASME B1.1 screw threads.
8. Stem: [**Aluminum**]<**Insert material**> and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

9. Display: Digital.
10. Accuracy: Plus or minus **2 deg F (1 deg C)**.

K. Thermometers, Light Activated - Remote Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Miljoco Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Miljoco Corporation**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Provide light-activated, remote-mounted thermometers from single manufacturer.
4. Case: Plastic, for wall mounting.
5. Scale(s): [**Deg F (deg C)**][**Deg F and deg C**].
6. Sensor: Bulb and thermister wire.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

7. Display: Digital.
8. Accuracy: Plus or minus **2 deg F (1 deg C)**.

L. Duct-Thermometer Mounting Brackets:

1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

M. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: [**CNR**][**or**][**CUNI**]<**Insert material**>.
4. Material for Use with Steel Piping: [**CRES**][**CSA**]<**Insert material**>.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: **NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,)** ASME B1.20.1 pipe threads.
7. Internal Threads: **1/2, 3/4, and 1 inch (13, 19, and 25 mm)**, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: [**Mixture of graphite and glycerin**]<**Insert material**>.

N. Pressure Gauges, Dial Type - Direct Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Ernst Flow Industries**]
    e. [**Flo Fab Inc**]
    f. [**Marsh Bellofram**]
    g. [**Miljoco Corporation**]
    h. [**Noshok**]
    i. [**Palmer Wahl Instrumentation Group**]
    j. [**REOTEMP Instrument Corporation**]
    k. [**Tel-Tru Manufacturing Company**]
    l. [**Trerice, H. O. Co**]
    m. [**WATTS; A Watts Water Technologies Company**]
    n. [**Weiss Instruments, Inc**]
    o. [**Weksler Glass Thermometer Corp.**]
    p. [**WIKA Instrument Corporation**]
    q. [**Winters Instruments - U.S.**]
    r. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Ernst Flow Industries**]
    e. [**Flo Fab Inc**]
    f. [**Marsh Bellofram**]
    g. [**Miljoco Corporation**]
    h. [**Noshok**]
    i. [**Palmer Wahl Instrumentation Group**]

j. [**REOTEMP Instrument Corporation**]
k. [**Tel-Tru Manufacturing Company**]
l. [**Trerice, H. O. Co**]
m. [**WATTS; A Watts Water Technologies Company**]
n. [**Weiss Instruments, Inc**]
o. [**Weksler Glass Thermometer Corp.**]
p. [**WIKA Instrument Corporation**]
q. [**Winters Instruments - U.S.**]
r. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, direct-mounted, metal-case pressure gauges from single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Liquid-filled**][**Sealed**][**Open-front, pressure-relief**][**Solid-front, pressure-relief**]<**Insert type**> type(s); [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi**|**START_SI**|**(kPa)**][|**END_SI**|**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Ring: [**Metal**][**Brass**][**Stainless steel**]<**Insert material**>.
13. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

O. Pressure Gauges, Dial Type - Direct Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Flo Fab Inc**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**Weiss Instruments, Inc**]
l. [**Weksler Glass Thermometer Corp.**]
m. [**WIKA Instrument Corporation**]
n. [**Winters Instruments - U.S.**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Flo Fab Inc**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**Weiss Instruments, Inc**]
l. [**Weksler Glass Thermometer Corp.**]
m. [**WIKA Instrument Corporation**]
n. [**Winters Instruments - U.S.**]
o. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, direct-mounted, plastic-case pressure gauges from a single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Sealed**]<**Insert type**> type; [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

P. Pressure Gauges, Dial Type - Remote Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Ernst Flow Industries**]
d. [**Flo Fab Inc**]
e. [**Marsh Bellofram**]
f. [**Miljoco Corporation**]
g. [**Noshok**]
h. [**Palmer Wahl Instrumentation Group**]
i. [**REOTEMP Instrument Corporation**]
j. [**Tel-Tru Manufacturing Company**]
k. [**Trerice, H. O. Co**]
l. [**WATTS; A Watts Water Technologies Company**]
m. [**Weiss Instruments, Inc**]

n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Ernst Flow Industries**]
d. [**Flo Fab Inc**]
e. [**Marsh Bellofram**]
f. [**Miljoco Corporation**]
g. [**Noshok**]
h. [**Palmer Wahl Instrumentation Group**]
i. [**REOTEMP Instrument Corporation**]
j. [**Tel-Tru Manufacturing Company**]
k. [**Trerice, H. O. Co**]
l. [**WATTS; A Watts Water Technologies Company**]
m. [**Weiss Instruments, Inc**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, remote-mounted, metal-case pressure gauges from a single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Liquid-filled**][**Sealed**]<**Insert type**> type; [**cast aluminum or drawn steel**][**metal**]<**Insert material**>; [**3-1/2-inch (90-mm)**][**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
13. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

Q. Pressure Gauges, Dial Type - Remote Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]

d. [**Noshok**]
e. [**Palmer Wahl Instrumentation Group**]
f. [**REOTEMP Instrument Corporation**]
g. [**Tel-Tru Manufacturing Company**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Noshok**]
e. [**Palmer Wahl Instrumentation Group**]
f. [**REOTEMP Instrument Corporation**]
g. [**Tel-Tru Manufacturing Company**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, remote-mounted, plastic-case pressure gauges from single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Sealed**]<**Insert type**> type; [**plastic**]<**Insert material**>; [**3-1/2-inch (90-mm)**][**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

R. Gauge Attachments:

1. Snubbers: ASME B40.100, brass; with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and [**piston**][**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of [**brass**][**stainless steel**][**steel**] pipe with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**] pipe threads.
3. Valves: [**Brass ball**][**Brass or stainless steel needle**], with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads.

S. Test Plugs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**IMI Flow Design, Inc.**]
    b. [**Miljoco Corporation**]
    c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
    d. [**Peterson Equipment Co., Inc**]
    e. [**Trerice, H. O. Co**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Weiss Instruments, Inc**]
    h. [**Weksler Glass Thermometer Corp.**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**IMI Flow Design, Inc.**]
    b. [**Miljoco Corporation**]
    c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
    d. [**Peterson Equipment Co., Inc**]
    e. [**Trerice, H. O. Co**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Weiss Instruments, Inc**]
    h. [**Weksler Glass Thermometer Corp.**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Provide test plugs from single manufacturer.
4. Description: Test-station fitting made for insertion in piping tee fitting.
5. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
6. Thread Size: [**NPS 1/4 (DN 8)**][**or**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe thread.
7. Minimum Pressure and Temperature Rating: [**500 psig at 200 deg F (3450 kPa at 93 deg C)**]<**Insert ratings**>.
8. Core Inserts: [**Chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber.

T. Test-Plug Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Peterson Equipment Co., Inc**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Blue Ribbon Corp.**]
    b. [**Peterson Equipment Co., Inc**]

c. **<Insert manufacturer's name>**

3. Source Limitations: Provide test-plug kits from single manufacturer.
4. Furnish [**one**]<**Insert number**> test-plug kit(s) containing [**one**][**two**] thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.
5. Low-Range Thermometer: Small, bimetallic insertion type with [**1- to 2-inch- (25- to 50-mm-)**]<**Insert dimension**> diameter dial and tapered-end sensing element. Dial range is to be at least [**25 to 125 deg F (minus 4 to plus 52 deg C)**]<**Insert temperature range**>.
6. High-Range Thermometer: Small, bimetallic insertion type with [**1- to 2-inch- (25- to 50-mm-)**]<**Insert dimension**> diameter dial and tapered-end sensing element. Dial range is to be at least [**0 to 220 deg F (minus 18 to plus 104 deg C)**]<**Insert temperature range**>.
7. Pressure Gauge: Small, Bourdon-tube insertion type with [**2- to 3-inch- (50- to 75-mm-)**]<**Insert dimension**> diameter dial and probe. Dial range shall be at least [**0 to 200 psig (0 to 1380 kPa)**]<**Insert range**>.
8. Carrying Case: Metal or plastic, with formed instrument padding.

U. Sight Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARCHON Industries, Inc**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Ernst Flow Industries**]
   d. [**John C. Ernst Co., Inc.**]
   e. [**KOBOLD Instruments, Inc. - USA**]
   f. [**OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARCHON Industries, Inc**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Ernst Flow Industries**]
   d. [**John C. Ernst Co., Inc.**]
   e. [**KOBOLD Instruments, Inc. - USA**]
   f. [**OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Provide sight flow indicators from single manufacturer.
4. Description: Piping inline-installation device for visual verification of flow.
5. Construction: Bronze or stainless steel body, with sight glass and [**ball, flapper, or paddle wheel**]<**Insert device**> indicator, and threaded or flanged ends.
6. Minimum Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1034 kPa)**]<**Insert value**>.
7. Minimum Temperature Rating: [**200 deg F (93 deg C)**]<**Insert temperature**>.
8. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
9. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

V. Flowmeters:

1. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
2. Flowmeters - Orifice:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**ABB, Process Automation Business**]
        2) [**Armstrong International, Inc**]
        3) [**Bell & Gossett; a Xylem brand**]
        4) [**Meriam Process Technologies**]
        5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
        6) <**Insert manufacturer's name**>

    b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

        1) [**ABB, Process Automation Business**]
        2) [**Armstrong International, Inc**]
        3) [**Bell & Gossett; a Xylem brand**]
        4) [**Meriam Process Technologies**]
        5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
        6) <**Insert manufacturer's name**>

    c. Source Limitations: Provide orifice flowmeters from single manufacturer.
    d. Description: Flowmeter with orifice plate and flanges, differential pressure sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
    e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
    f. Orifice Plate: Wafer-orifice-type, calibrated, flow-measuring element; for installation between orifice plate pipe flanges.

        1) Design: Differential-pressure-type measurement for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
        2) Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
        3) Minimum Pressure Rating: [**300 psig (2070 kPa)**]<**Insert value**>.
        4) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.

    g. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor, and has **6-inch- (150-mm-)** diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.

        1) Scale Divisions: <**Insert value**>[**gpm**|**START_SI| (Lps)**][**gpm and Lps**]END_SI.
        2) Accuracy: Plus or minus [**1 percent between 20 and 80 percent of scale range**]<**Insert accuracy**>.

    h. Portable Indicators: Handheld, differential-pressure type, calibrated for connected sensor and having two **12 ft. (3.7 m)** hoses, with carrying case.

        1) Scale Divisions: <**Insert value**>[**gpm**|**START_SI| (Lps)**][**gpm and Lps**]END_SI.
        2) Accuracy: Plus or minus [**2 percent between 20 and 80 percent of scale**

range]<**Insert accuracy**>.

i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Conversion Chart: Flow rate data compatible with sensor and indicator.
k. Operating Instructions: Include complete instructions with each flowmeter.

3. Flowmeters - Pitot Tube:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Meriam Process Technologies**]
3) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Meriam Process Technologies**]
3) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
6) <**Insert manufacturer's name**>

c. Source Limitations: Provide pitot-tube flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Insertion type; for inserting probe in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Differential-pressure-type measurement for [**oil**][**water**]<**Insert fluid**>.
2) Construction: Stainless steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provide way to permit removal of probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Integral Transformer: For low-voltage power connection.
i. Accuracy: Plus or minus [**3**]<**Insert number**> percent.
j. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
k. Operating Instructions: Include complete instructions with each flowmeter.

4. Flowmeters - Turbine:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**ERDCO Engineering Corp**]
2) [**Hoffer Flow Controls, Inc**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**SeaMetrics, Inc.**]
6) [**Spirax Sarco Limited**]
7) [**Veris Industries**]
8) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ERDCO Engineering Corp**]
2) [**Hoffer Flow Controls, Inc**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**SeaMetrics, Inc.**]
6) [**Spirax Sarco Limited**]
7) [**Veris Industries**]
8) <**Insert manufacturer's name**>

c. Source Limitations: Provide turbine flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
2) Construction: Bronze or stainless steel body, with plastic turbine or impeller.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provide way to permit removal of probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**180 deg F (82 deg C)**]<**Insert temperature**>.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Accuracy: Plus or minus [**1-1/2**]<**Insert number**> percent.
i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Operating Instructions: Include complete instructions with each flowmeter.

5. Flowmeters - Venturi:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Gerand Engineering Co**]
3) [**Hyspan Precision Products, Inc**]

4) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
5) [**Preso Meters; Badger Meter Inc.**]
6) [**Rosemount; Emerson Electric Co., Automation Solutions**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Gerand Engineering Co**]
3) [**Hyspan Precision Products, Inc**]
4) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
5) [**Preso Meters; Badger Meter Inc.**]
6) [**Rosemount; Emerson Electric Co., Automation Solutions**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Provide venture flowmeters from single manufacturer.
d. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Flow-Measuring Element:

1) Design: Differential-pressure-type measurement for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
2) Venturi type with [**in-line**][**or**][**insertion**] element.
3) Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
4) Minimum Pressure Rating: [**250 psig (1725 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.
6) End Connections for NPS 2 (DN 50) and Smaller: Threaded.
7) End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
8) Flow Range: Flow-measuring element and flowmeter are to cover operating range of equipment or system served.

g. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and has **6-inch- (150-mm-)** diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

1) Scale: <**Insert value**> **gpm (Lps)**.
2) Accuracy: Plus or minus [**1 percent between 20 and 80 percent of scale range**]<**Insert accuracy**>.

h. Portable Indicators: Handheld, differential-pressure type, calibrated for connected flowmeter element and has two **12 ft. (3.7 m)** hoses, with carrying case.

1) Scale: <**Insert value**> **gpm (Lps)**.
2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Conversion Chart: Flow rate data compatible with sensor.
k. Operating Instructions: Include complete instructions with each flowmeter.

6. Flowmeters - Vortex Shedding:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ABB, Process Automation Business**]
2) [**Endress+Hauser**]
3) [**ISTEC Corporation**]
4) [**Rosemount; Emerson Electric Co., Automation Solutions**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ABB, Process Automation Business**]
2) [**Endress+Hauser**]
3) [**ISTEC Corporation**]
4) [**Rosemount; Emerson Electric Co., Automation Solutions**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Provide vortex-shedding flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in **gpm (Lps)**.

1) Design: Flow-obstruction device, vortex-measurement type for [**gas**][**steam**][**and**][**liquids**].
2) Construction: Stainless steel body, with integral transmitter and direct-reading scale.
3) Minimum Pressure Rating: [**1000 psig (6900 kPa)**]<**Insert value**>.
4) Minimum Temperature Rating: [**500 deg F (260 deg C)**]<**Insert temperature**>.
5) Integral Transformer: For low-voltage power operation.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Accuracy: Plus or minus [**0.25**]<**Insert number**> percent for liquids and [**0.75**]<**Insert number**> percent for gases.
i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Operating Instructions: Include complete instructions with each flowmeter.

7. Thermal-Energy Meters - Turbine:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ISTEC Corporation**]
2) [**ONICON Incorporated**]
3) [**Preso Meters; Badger Meter Inc.**]
4) [**Veris Industries**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**ISTEC Corporation**]
2) [**ONICON Incorporated**]
3) [**Preso Meters; Badger Meter Inc.**]
4) [**Veris Industries**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Provide turbine thermal-energy meters from single manufacturer.
d. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
e. Description: System with[**strainer,**] flow sensor, two temperature sensors, transmitter, indicator, and connecting wiring.
f. Flow Sensor: Turbine type; for inserting in pipe fitting or for installing in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for [**gas**][**oil**][**steam**][**water**].
2) Construction: Bronze or stainless steel body, with plastic turbine or impeller.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provision to remove probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**180 deg F (82 deg C)**]<**Insert temperature**>.

g. Temperature Sensors: Insertion-type sensor-transducer.
h. Indicator: Solid-state, integrating-type meter[**with integral battery pack**]; for wall mounting.

1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or **British thermal units (joules)**.
2) Battery Pack: Five-year lithium battery.

i. Accuracy: Plus or minus [**1**]<**Insert number**> percent.
j. Display: Visually indicates total fluid volume in **gallons (liters)** and thermal-energy flow in kilowatts per hour or **British thermal units (joules)**.
k. Strainer: Full size of main line piping.
l. Operating Instructions: Include complete instructions with each thermal-energy meter system.

8. Thermal-Energy Meters - Ultrasonic:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Badger Meter, Inc.**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Siemens Industry, Inc., Energy Management Division**]
6) [**Veris Industries**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Badger Meter, Inc.**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Siemens Industry, Inc., Energy Management Division**]
6) [**Veris Industries**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Provide ultrasonic thermal-energy meters from single manufacturer.
d. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
e. Description: Meter with flow sensor, two temperature sensors, transmitter, indicator, and connecting wiring.
f. Flow Sensor: Transit-time ultrasonic type with transmitter.
g. Temperature Sensors: Insertion-type or strap-on transducer.
h. Indicator: Solid-state, integrating-type meter[**with integral battery pack**].

1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or **British thermal units (joules)**.
2) Battery Pack: Five-year lithium battery.

i. Accuracy: Plus or minus [**1**]<**Insert number**> percent.
j. Display: Visually indicates total fluid volume in **gallons (liters)** and thermal-energy flow in kilowatts per hour or **British thermal units (joules)**.
k. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS - GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKED EXPANSION JOINTS

A. Install packed expansion joints with packing suitable for fluid service.

3.3 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows packless expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.4 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

A. Install grooved-joint expansion joints to grooved-end steel piping.

3.5 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install [**one**][**two**] guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than [**four**]<**Insert number**> pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.6 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least [**five**]<**Insert number**> pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least [**four**]<**Insert number**> pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least [**four**]<**Insert number**> pipe fittings, including tee in main.

3.7 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch (25-mm)**][**2-inch (50-mm)**]<**Insert dimension**> annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches (50 mm)**]<**Insert dimension**> above finished floor level.

3. Using [**grout**][**or**][**silicone sealant**], seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.8 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [**grout**][**or**][**silicone sealant**], seal space around outside of sleeves.

3.9 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to **3 inches (76 mm)** above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.10 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.11 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.12 INSTALLATION OF METERS AND GAUGES

A. Install thermowells with socket extending [**a minimum of 2 inches (50 mm) into fluid**][**one-third of pipe diameter**][**to center of pipe**] and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator.

H. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.

I. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

J. Install remote-mounted pressure gauges on panel.

K. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

L. Install valve and syphon fitting in piping for each pressure gauge for steam.

M. Install test plugs in piping tees.

N. Install flow indicators in piping systems in accessible positions for easy viewing.

O. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

P. Install flowmeter elements in accessible positions in piping systems.

Q. Install wafer-orifice flowmeter elements between orifice-type pipe flanges.

R. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

S. Install permanent indicators on walls or brackets in accessible and readable positions.

T. Install connection fittings in accessible locations for attachment to portable indicators.

U. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

V. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.
8. <**Insert location**>.

W. Install pressure gauges in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.
4. <**Insert location**>.

3.13 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.14 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.15 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.16 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**]<**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**]<**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [**Sleeves with waterstops**][**or**][**stack-sleeve fittings**].

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.17 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, [**steel**][**cast brass**][**or split-plate steel**] with polished, chrome-plated finish.

3. Insulated Piping:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
    c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
    c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.18 THERMOMETER APPLICATION

A. Thermometers at inlet and outlet of each hydronic zone are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic boiler are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Thermometers at inlets and outlets of each chiller are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

E. Thermometers at inlets and outlets of each hydronic heat exchanger are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

F. Thermometers at inlet and outlet of each hydronic heat-recovery unit are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.

5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

G. Thermometers at inlet and outlet of each thermal-storage tank are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

H. Thermometers at outside-, return-, supply-, and mixed-air ducts are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.

I. Thermometer stems are to be of length to match thermowell insertion length.

3.19 THERMOMETER SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. [**Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C)**][**Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C**].
2. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
3. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
4. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].

B. Scale Range for Condenser-Water Piping:

1. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
2. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
3. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
4. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**].
5. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].

C. Scale Range for Heating, Hot-Water Piping:

1. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
2. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**] .
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].
4. [**50 to 400 deg F (0 to 200 deg C)**][**50 to 400 deg F and 0 to 200 deg C**].
5. [**50 to 550 deg F (10 to 300 deg C)**][**50 to 550 deg F and 10 to 300 deg C**].

D. Scale Range for Steam and Steam-Condensate Piping:

1. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
2. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].
4. [**50 to 400 deg F (0 to 200 deg C)**][**50 to 400 deg F and 0 to 200 deg C**].

E. Scale Range for Air Ducts:

1. [Minus 40 to plus 110 deg F (Minus 40 to plus 45 deg C)][Minus 40 to plus 110 deg F and minus 40 to plus 45 deg C].
2. [Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C)][Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C].
3. [0 to 100 deg F (Minus 20 to plus 50 deg C)][0 to 100 deg F and minus 20 to plus 50 deg C].
4. [0 to 150 deg F (Minus 20 to plus 70 deg C)][0 to 150 deg F and minus 20 to plus 70 deg C].
5. [0 to 250 deg F (0 to 150 deg C)][0 to 250 deg F and 0 to 150 deg C].
6. [20 to 240 deg F (0 to 150 deg C)][20 to 240 deg F and 0 to 150 deg C].
7. [30 to 240 deg F (0 to plus 115 deg C)][30 to 240 deg F and 0 to plus 115 deg C].
8. [50 to 400 deg F (0 to 200 deg C)][50 to 400 deg F and 0 to 200 deg C].

3.20 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each pressure-reducing valve are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each chiller chilled-water and condenser-water connection are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each pump are to be the following:

1. [**Liquid-filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

3.21 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. [30 in. Hg to 15 psi (minus 100 to 0 kPa)][30 in. Hg to 15 psi and minus 100 to 0 kPa].
2. [0 to 30 psi (0 to 240 kPa)][0 to 30 psi and 0 to 240 kPa].
3. [0 to 100 psi (0 to 600 kPa)][0 to 100 psi and 0 to 600 kPa].
4. [0 to 160 psi (0 to 1100 kPa)][0 to 160 psi and 0 to 1100 kPa].
5. [0 to 200 psi (0 to 1400 kPa)][0 to 200 psi and 0 to 1400 kPa].
6. [0 to 300 psi (0 to 2500 kPa)][0 to 300 psi and 0 to 2500 kPa].
7. [0 to 600 psi (0 to 4000 kPa)][0 to 600 psi and 0 to 4000 kPa].

B. Scale Range for Condenser-Water Piping:

1. [30 in. Hg to 15 psi (minus 100 to 0 kPa)][30 in. Hg to 15 psi and minus 100 to 0 kPa].
2. [0 to 30 psi (0 to 240 kPa)][0 to 30 psi and 0 to 240 kPa].
3. [0 to 100 psi (0 to 600 kPa)][0 to 100 psi and 0 to 600 kPa].
4. [0 to 160 psi (0 to 1100 kPa)][0 to 160 psi and 0 to 1100 kPa].
5. [0 to 200 psi (0 to 1400 kPa)][0 to 200 psi and 0 to 1400 kPa].

6. [0 to 300 psi (0 to 2500 kPa)][**0 to 300 psi and 0 to 2500 kPa**].
7. [0 to 600 psi (0 to 4000 kPa)][**0 to 600 psi and 0 to 4000 kPa**].

C. Scale Range for Heating, Hot-Water Piping:

1. [30 in. Hg to 15 psi (minus 100 to 0 kPa)][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [0 to 30 psi (0 to 240 kPa)][**0 to 30 psi and 0 to 240 kPa**].
3. [0 to 100 psi (0 to 600 kPa)][**0 to 100 psi and 0 to 600 kPa**].
4. [0 to 160 psi (0 to 1100 kPa)][**0 to 160 psi and 0 to 1100 kPa**].
5. [0 to 200 psi (0 to 1400 kPa)][**0 to 200 psi and 0 to 1400 kPa**].
6. [0 to 300 psi (0 to 2500 kPa)][**0 to 300 psi and 0 to 2500 kPa**].
7. [0 to 600 psi (0 to 4000 kPa)][**0 to 600 psi and 0 to 4000 kPa**].

D. Scale Range for Steam Piping:

1. [30 in. Hg to 15 psi (minus 100 to 0 kPa)][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [0 to 30 psi (0 to 240 kPa)][**0 to 30 psi and 0 to 240 kPa**].
3. [0 to 100 psi (0 to 600 kPa)][**0 to 100 psi and 0 to 600 kPa**].
4. [0 to 160 psi (0 to 1100 kPa)][**0 to 160 psi and 0 to 1100 kPa**].
5. [0 to 200 psi (0 to 1400 kPa)][**0 to 200 psi and 0 to 1400 kPa**].
6. [0 to 300 psi (0 to 2500 kPa)][**0 to 300 psi and 0 to 2500 kPa**].
7. [0 to 600 psi (0 to 4000 kPa)][**0 to 600 psi and 0 to 4000 kPa**].

3.22 FLOWMETER APPLICATION

A. Flowmeters for Chilled-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

B. Flowmeters for Condenser-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

C. Flowmeters for Heating, Hot-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

D. Flowmeters for Steam and Steam-Condensate Piping: [**Orifice**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

3.23 THERMAL-ENERGY METER APPLICATION

A. Thermal-Energy Meters for Chilled-Water Piping: [**Turbine**][**Ultrasonic**] type.

B. Thermal-Energy Meters for Condenser-Water Piping: [**Turbine**][**Ultrasonic**] type.

C. Thermal-Energy Meters for Heating, Hot-Water Piping: [**Turbine**][**Ultrasonic**] type.

D. Thermal-Energy Meters for Steam and Steam-Condensate Piping: [**Turbine**][**Ultrasonic**] type.

END OF SECTION 07 63 00 00A

Task	Specification	Specification Description
07 63 00 00	07 62 00 00	Sheet Metal Flashing And Trim
07 63 00 00	22 05 00 00	Common Work Results for Plumbing

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SECTION 07 65 16 00 - BUILT-UP ASPHALT ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Built-up asphalt roofing (BUR) system.
2. Roofing membrane sheet materials.
3. Base flashing sheet.
4. Asphalt materials.
5. Accessory roofing system materials.
6. Substrate board.
7. Vapor retarder.
8. Roof insulation and accessories.
9. Cover board.
10. Electronic leak-detection (ELD) materials.
11. Roof coating system.
12. Walkways.

B. Section contains installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and roofing terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of steel roof deck and roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Crickets, saddles, and tapered edge strips, including slopes.
7. Insulation-fastening patterns for corner, perimeter, and field-of-roof locations.
8. Tie-in with adjoining air barrier.

C. Samples for Verification: For the following products, as directed by the Owner:

1. Cap Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
2. Base Flashing Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
3. Roof Coating System: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
4. Walkways: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, for tests performed by an independent, qualified testing agency indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roof membrane manufacturer, stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in accordance with roofing system manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit Roofing System Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roof membrane to resist impact damage when tested in accordance with ASTM D3746/C3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical to that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 BUILT-UP ASPHALT ROOFING (BUR) SYSTEM

A. BUR Roofing System Components: See the following articles for individual roof materials required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Building Products of Canada Corp.**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Malarkey Roofing Products**]
h. [**Tamko Building Products LLC**]
i. [**Tremco Incorporated**]

2.4 ROOFING MEMBRANE SHEET MATERIALS

A. SBS-Modified-Bitumen, Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, [**Type I**][**Type II**][**Type III**], SBS-modified asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.

B. Asphalt-Coated, Glass-Fiber-Mat Base Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

C. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II, venting, nonperforated, asphalt-impregnated and -coated, glass-fiber base sheet with mineral granule surfacing on bottom surface.

D. Asphalt-Coated, Organic-Felt Base Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

E. Ply Sheet: ASTM D2178/D2178M, [**Type IV**][**Type VI**], asphalt-impregnated, glass-fiber felt.

F. Cap Sheet: ASTM D3909/D3909M, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.

2.5 BASE FLASHING SHEET

A. Asphalt-Impregnated, Glass-Fiber-Mat Backer Sheet: ASTM D2178/D2178M, [**Type IV**][**Type VI**], asphalt-impregnated, glass-fiber felt.

B. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

C. Asphalt-Coated, Organic-Felt Backer Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

D. SBS-Modified-Bitumen Backer Sheet: [**ASTM D6164/D6164M, Type I or II, Grade S, reinforced with polyester fabric**][**ASTM D6163/D6163M, Type I or II, Grade S, reinforced with glass fibers**][**ASTM D6162/D6162M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers**]; smooth surfaced; suitable for application method specified.

E. SBS-Modified-Bitumen, Granule-Surfaced Flashing Sheet: [**ASTM D6164/D6164M, Type I or II, Grade G, polyester reinforced**][**ASTM D6163/D6163M, Type I or II, Grade G, glass-fiber reinforced**][**ASTM D6162/D6162M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers**], granule-surfaced; suitable for application method specified, and as follows:

1. Granule Color: [**White**][**Gray**][**Tan**].

F. SBS-Modified-Bitumen, Metal-Surfaced Flashing Sheet: ASTM D6298, glass-fiber-reinforced, SBS-modified, metal-foil-surfaced asphalt sheet, suitable for application method specified, and as follows:

1. Metal Surfacing: [**Aluminum**][**Copper**][**Stainless steel**][**Aluminum, fluoropolymer-coated finish, of color and gloss selected by Architect from manufacturer's full range**].

G. APP-Modified-Bitumen, Smooth-Surfaced Flashing Sheet: [**ASTM D6222/D6222M, Type I or II, Grade S, polyester-reinforced**][**ASTM D6223/D6223M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers**], smooth surfaced, suitable for application method specified.

H. APP-Modified-Bitumen, Granule-Surfaced Flashing Sheet: [**ASTM D6222/D6222M, Type I or II, Grade G, polyester-reinforced**][**ASTM D6223/D6223M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers**], granule-surfaced, suitable for application method specified, and as follows:

1. Granule Color: [**White**][**Gray**][**Tan**].

I. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D1668/D1668M, Type I.

J. Liquid Flashing System: Roof membrane manufacturer's standard one- or two-part moisture curing resin with low solvent content, consisting of a primer, flashing cement, and scrim.

2.6 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D41/D41M.

B. Roofing Asphalt: ASTM D312/D312M, [**Type III**][**Type IV**][**Type III or IV as recommended by roofing system manufacturer for application**], suitable for installation method specified.

C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M, suitable for installation method specified.

2.7 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing system components, and suitable for installation method specified.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

B. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

C. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

D. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft. (0.16 kg/sq. m)**.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.

G. Cold-Applied Asphalt Adhesive: ASTM D4479/D4479M, Type I or Type II, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.

H. Cold-Applied Polymer-Modified Asphalt Adhesive: Roof membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system, base flashings, and aggregate surfacing adhesive.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing manufacturer for application.

J. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.

L. Aggregate Surfacing: ASTM D1863/D1863M, No. 6 or No. 67, clean, dry, opaque, [**water-worn gravel or crushed stone, free of sharp edges**][**crushed slag, free of sharp edges**].

M. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.8 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. High-Density Polyisocyanurate Roof Substrate Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.9 VAPOR RETARDER

A. Rubberized Asphalt Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

D. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt impregnated.

2.10 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured[**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.0-lb/cu. ft. (48-kg/cu. m) minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DuPont de Nemours, Inc.**]
b. [**Kingspan Insulation LLC**]
c. [**Owens Corning**]
d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.

3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

    a. Base Layer: [1-1/2 inches (38 mm)]

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578 Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) minimum density, 13 psi (90 kPa) minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Carlisle Syntec Systems**]
    c. [**Cellofoam North America, Inc.**]
    d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per 1 inch (25 mm).
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

    a. Base Layer: [1-1/2 inches (38 mm)]

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35-lb/cu. ft. (22-kg/cu. m)**][**Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m)**][**Type IX, 1.8-lb/cu. ft. (29-kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cellofoam North America, Inc.**]
    b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Polyiso Roof and Wall Insulation**]
    b. [**Carlisle Syntec Systems**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Elevate; Holcim Building Envelope**]
    e. [**GAF**]
    f. [**Hunter Panels; a Carlisle company**]

g. [**IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**]
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Hunter Panels; a Carlisle company**]
f. [**Insulfoam; a Carlisle Company**]
g. [**Johns Manville; a Berkshire Hathaway company**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

G. Perlite Board Insulation: ASTM C728, Type I, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GAF**]
b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**]
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Ridge Fiberboard**]
b. [**GAF**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Homasote Company**]
e. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

a. Base Layer: [**1 inch (25 mm)**][**2 inches (51 mm)**].

I. Cellular-Glass Board Insulation: ASTM C552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pittsburgh Corning Corporation**]

2. Thermal Resistance: R-value of 3.44 per **1 inch (25 mm)**.
3. Size: **24 by 48 inches (600 by 1200 mm)**.

J. Mineral Wool Board Insulation - Multidensity: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with an **11.2-lb/cu. ft. (180-kg/cu. m)** density and a lower layer with a **7.5-lb/cu. ft. (120-kg/cu. m)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness:

a. Base Layer: [**2 inches (51 mm)**].

4. Face Treatment: Bitumen coating.

K. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having a **12.5-lb/cu. ft. (200-kg/cu. m)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.
4. Face Treatment: Bitumen coating.

L. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

   a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
   b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

M. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use and compatible with other roofing system components.

N. Insulation Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing membrane manufacturer.

O. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread spray-applied, low-rise, two-component urethane adhesive.
4. Verify adhesives and sealants comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesives: 80 g/L.
   f. PVC Welding Compounds: 510 g/L.
   g. Other Adhesives: 250 g/L.
   h. Single-Ply Roof Membrane Sealants: 450 g/L.
   i. Nonmembrane Roof Sealants: 300 g/L.
   j. Sealant Primers for Nonporous Substrates: 250 g/L.
   k. Sealant Primers for Porous Substrates: 775 g/L.

5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

P. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

Q. Wood Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."

R. Tapered Edge Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1,**

cellulosic-fiber insulation board].

2.11 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use; compatible with other roofing system components and suitable for installation method specified.

B. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

I. Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

2.12 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.13 ROOF COATING SYSTEM

A. Primer: Roof coating manufacturer's standard primer to enhance the adhesion of roof coating to substrate.

B. Asphalt Emulsion Coating, Asbestos Free: ASTM D1227/D1227M, Type II, [**Class 1, mineral-colloid-emulsified, fibered**][**Class 2, chemically emulsified, filled or fibered**].

C. Asphalt Emulsion Coating, Nonfibered: ASTM D1227/D1227M, Type III, [**Class 1, mineral-colloid-emulsified**][**Class 2, chemically emulsified**].

D. Aluminum-Pigmented Asphaltic Coating: ASTM D2824/D2824M, [**Type I, nonfibered**][**Type III, fibered, asbestos-free**].

E. Acrylic Elastomer Emulsion Coating: ASTM D6083/D6083M, formulated for use on bituminous roof surfaces.

F. Silicone Coating: ASTM D6694/D6694M, formulated for use on bituminous roof surfaces.

G. Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.14 WALKWAYS

A. Walkway Pads: [**Reinforced asphaltic composition pads with slip-resisting mineral-granule surface**][**Polymer-modified, reconstituted rubber pads with slip-resisting textured surface**], manufactured as a traffic pad for foot traffic and acceptable to roofing membrane manufacturer.

1. Pad Size: Approximately [**36 by 60 inches (914 mm by 1524 mm)**][**30 by 30 inches (762 mm by 762mm)**].
2. Color: [**Contrasting with cap sheet**][**Gray**][**Yellow**][**White**].

B. Walkway Cap Sheet Strips: Matching cap sheet; suitable for installation method specified, and as follows:

1. Size: [36 by 60 inches (914 mm by 1524 mm)].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.

    a. Test Frequency: One test probe per each [1000 sq. ft. (93 sq. m)], or portion thereof, of roof deck, with not less than three test probes.
    b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify that adjacent cementitious wood fiber panels are vertically aligned to within 1/8-inch (3 mm) at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing manufacturer's written installation instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of **3/4 gal./100 sq. ft. (0.3 L/sq. m)**, and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roof system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind-uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof decks in accordance with roof deck manufacturer's written installation instructions.

3.3 INSTALLATION OF BUILT-UP ASPHALT ROOFING SYSTEM, GENERAL

A. Install roofing system in accordance with manufacturer's written instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Asphalt Heating:

1. Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before application.
2. Circulate asphalt during heating.

a. Do not raise asphalt temperature above equiviscous temperature range more than one hour before time of application.

3. Do not exceed asphalt manufacturer's recommended temperature limits during asphalt heating.
4. Do not heat asphalt within **25 deg F (14 deg C)** of flash point.
5. Discard asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.

a. Apply hot roofing asphalt within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.

F. SEBS-Modified Asphalt Heating: Heat and apply roofing asphalt in accordance with roofing manufacturer's written instructions.

G. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints,

entering building, or damaging roofing components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with recommendations in [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
2. Continuously seal side and end laps.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.

6. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

D. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:

1. [16 feet (4.88 m)] apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
2. [48 inches (1200 mm)] apart for roof slopes greater than 3 inches per 12 inches (3:12).

E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane with vertical surfaces or angle changes greater than 45 degrees.

3.7 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
3. Trim cover board so that water flow is unrestricted.
4. Cut and fit cover board tight to nailers, projections, and penetrations.
5. Adhere cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install sheathing paper over cover board and immediately beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF BUILT-UP ROOFING MEMBRANE

A. Install roofing membrane in accordance with roofing system manufacturer's written installation instructions and applicable recommendations of NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:

1. Base Sheet: [**One**][**One, installed over sheathing paper**].
2. Number of Ply Sheets: [**Two**][**Three**][**Four**].
3. Surfacing: [**Aggregate**][**Asphalt surfacing or coating**][**Mineral-granule-surfaced cap sheet**].
4. Mineral-granule-surfaced cap sheet is in addition to number of ply sheets specified.

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Where roof slope exceeds [**1/2 inch per 12 inches (1:24)**][**3/4 inch per 12 inches (1:18)**], install roofing ply sheets parallel with slope.

1. Backnail roofing ply sheets to [**nailer strips**][**substrate**] in accordance with roofing system manufacturer's written instructions.

D. Coordinate installation of roofing, so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

E. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of **2 inches (51 mm)** and **6 inches (150 mm)**, respectively.

F. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:

1. Mechanically fasten to substrate.
2. Spot or strip mop to substrate with hot roofing asphalt.
3. Adhere to substrate [**in a solid mopping of hot roofing asphalt**][**using cold-applied asphalt adhesive**][**using cold-applied polymer-modified asphalt adhesive**].

G. Install [**three**][**four**] ply sheets, starting at low point of roof.

1. Align ply sheets without stretching.
2. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane.

    a. Shingle in direction to shed water.

3. Extend ply sheets over and terminate above cants.
4. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
5. Embed each ply sheet in cold-applied asphalt adhesive applied at a rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
6. Embed each ply in cold-applied polymer-modified asphalt adhesive applied at a rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
7. Install ply sheets without wrinkles, tears, and free from air pockets.

H. Cap Sheet: Install lapped granulated cap sheet, starting at low point of roofing.

1. Offset laps from laps of preceding ply sheets, and align cap sheet without stretching.
2. Lap in direction to shed water.
3. Extend cap sheet over and terminate above cants.
4. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing system manufacturer.
5. Embed each ply sheet in cold-applied asphalt adhesive applied at a rate required by roofing

system manufacturer.

6. Embed each ply in cold-applied polymer-modified asphalt adhesive applied at a rate required by roofing system manufacturer.
7. Install cap sheet without wrinkles, tears, and free from air pockets.

I. Aggregate Surfacing: After installing and testing roofing, base flashing, and stripping, promptly apply flood coat to roof surface with [**60 lb/100 sq. ft. (3.0 kg/sq. m) of hot roofing asphalt**][**cold-applied polymer-modified asphalt adhesive at rate recommended by roof system manufacturer**]. [**While flood coat is hot and fluid, cast**][**Cast**] the following average weight of aggregate in a uniform course:

1. Aggregate Weight: [**400 lb/100 sq. ft. (20 kg/sq. m)**][**300 lb/100 sq. ft. (15 kg/sq. m)**].
2. If aggregate surfacing is delayed, promptly apply glaze coat of [**hot roofing asphalt at a rate of 10 lb/100 sq. ft. (0.5 kg/sq. m)**][**cold-applied polymer-modified asphalt adhesive at a rate recommended by roof system manufacturer**].

J. Glaze-coat roofing surface with hot roofing asphalt applied at a rate of **10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m)**.

3.10 INSTALLATION OF FLASHING AND STRIPPING

A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates in accordance with roofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Application: [**Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants**][**Adhere backer sheet to substrate**] in [**a solid mopping of hot roofing asphalt**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**].
3. Flashing Sheet Application, Hot: [**Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer**][**Torch-apply flashing sheet to substrate**].
4. Flashing Sheet Application, Cold: Adhere flashing sheet to substrate in [**cold-applied adhesive**][**cold-applied polymer-modified adhesive**][**asphalt roofing cement**] at rate required by roofing manufacturer.

B. Extend base flashing up walls or parapets a minimum of **8 inches (200 mm)** above built-up roofing and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing[**with a strip of glass-fiber fabric set in asphalt roofing cement**].

D. Install liquid flashing system in accordance with manufacturer's recommendations.

1. Extend liquid flashing not less than **3 inches (76 mm)** in all directions from edges of item being flashed.
2. Embed granules, matching color of roof membrane, into wet compound.

E. Install stripping in accordance with roofing system manufacturer's written instructions, where metal flanges and edgings are set on roofing membrane.

1. Install flashing sheet stripping in a continuous coating of asphalt roofing cement, in [**a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C), and extend onto roofing membrane**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**].
2. Install flashing sheet stripping by heat welding and extend onto roofing membrane.
3. Install stripping of not fewer than two roofing ply sheets, setting each ply in a continuous coating of asphalt roofing cement, in [**a solid mopping of hot roofing asphalt**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**], and extend onto roofing membrane **4 inches (100 mm)** and **6 inches (150 mm)**, respectively.

F. Roof Drains: Set [**30-by-30-inch (760-by-760-mm)**] **4-pound (1.8-kg)** lead flashing in bed of asphaltic adhesive on completed roofing membrane.

1. Cover metal flashing with roofing cap sheet stripping, and extend a minimum of [**4 inches (100 mm)**][**6 inches (150 mm)**] beyond edge of metal flashing onto field of roofing membrane.
2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping in accordance with roofing manufacturer's written instructions.

3.11 INSTALLATION OF ROOF COATING SYSTEM

A. Apply coating to [**roofing membrane**][**base flashings**] in accordance with manufacturer's written instructions, by spray, roller, or other suitable application method[**, to provide a dry film thickness of not less than 20 mils (0.5 mm)**].

3.12 INSTALLATION OF WALKWAYS

A. Walkway Pads: Install walkway pads, using units of size indicated or, if not indicated, of manufacturer's standard size, in accordance with walkway pad manufacturer's written instructions.

1. Install walkways at following locations:

    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    d. Top and bottom of each roof access ladder.
    e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    f. Locations indicated on Drawings.
    g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining pads.
3. Set walkway pads [**in additional pour coat of hot roofing asphalt**][**in cold-applied adhesive**][**in cold-applied polymer-modified adhesive**] after sweeping away loose aggregate surfacing.

B. Walkway Cap-Sheet Strips: Install walkway cap-sheet strips, approximately **36 inches (914 mm)** wide and in lengths not exceeding **10 feet (3 m)**, over roofing membrane, using same application method as used for roofing cap sheet.[**Install walkway cap-sheet strips before flood coat and aggregate surface is applied.**]

1. Install walkways strips at following locations:

    a. Perimeter of each rooftop unit.

b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining strips.

C. Roof-Paver Walkways: Install walkway roof pavers in accordance with roofing manufacturer's written instructions.

1. Install roof paver walkways at following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjacent roof pavers.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roofing area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Perform tests before overlying construction is placed.
b. Flood to an average depth of [**2-1/2 inches (65 mm)**] with a minimum depth of [**1 inch (25**

mm)] and not exceeding a depth of [4 inches (100 mm)]. Maintain 2 inches (51 mm) of clearance from top of base flashing.
c. Flood each area for [**24**][**48**][**72**] hours.
d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.

a. Perform tests before overlying construction is placed.
b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M.

a. Perform tests before overlying construction is placed.
b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with SPRI/RCI NT-1.

a. Perform tests before overlying construction is placed.
b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing system as follows:

1. Determine approximate quantities of components within roofing system in accordance with ASTM D3617/D3617M.
2. Examine test specimens for interply voids in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
3. Repair areas where test cuts were made in accordance with roofing manufacturer's written

instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify the Owner 48 hours in advance of date and time of inspection.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.14 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.15 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own

cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and will afford reasonable opportunity for Roofing System Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 65 16 00

SECTION 07 65 16 00A - COATED FOAMED ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Spray-applied, coated, polyurethane foam roofing.

1. Polyurethane foam.
2. Urethane coatings.
3. Silicone coatings.
4. Acrylic coatings.
5. Substrate board.
6. Accessory materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking, curbs, cants, and nailers.
2. Section 072119 "Foamed-In-Place Insulation" for spray-applied polyurethane foam specified as general building insulation within walls and rafter spaces.
3. Section 076200 "Sheet Metal Flashing and Trim" for foam stops, roof penetration flashings, and counterflashings.
4. Section 079200 "Joint Sealants" for joint sealants, fillers, and preparation.

1.2 DEFINITIONS

A. Applicator: A qualified person employed to apply spray-applied, coated, polyurethane foam roofing.

B. Installer: A qualified firm contracted to install spray-applied, coated, polyurethane foam roofing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to coated foamed roofing, including, but not limited to, the following:

a. Load limitations on in-place roofing.
b. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Surface preparation specified in other Sections.
d. Minimum curing period.
e. Forecasted weather conditions.
f. Special details and sheet flashings.
g. Repairs.

1.4 ACTION SUBMITTALS

A. Product Data:[**Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties.**]

1. Polyurethane foam.
2. Urethane coatings.
3. Silicone coatings.
4. Acrylic coatings.
5. Substrate board.
6. Accessory materials.

B. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

C. Samples for Initial Selection: For each type of exposed product, finish, and color.

1. Include Samples of accessory materials and accessories involving color and finish selection.

D. Samples for Verification: For coated foamed roofing, prepared on Samples of size indicated below:

1. Samples, **24 by 24 inches (600 by 600 mm)**, on rigid backing, showing polyurethane foam of thickness required and stepped coatings in colors required to illustrate buildup of coated foamed roofing.
2. Include Samples of accessories to verify color and finish selected.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For SPFA-qualified [**Installer**][**applicators**].

B. Product Certificates: For each type of coated foam roofing.

C. Evaluation Reports: For coated foamed roofing, from ICC-ES.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For coated foamed roofing to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified coated-foamed-roofing installer who is approved, authorized, or licensed by coating manufacturer for installation of coating manufacturer's product over polyurethane foam.

1. Engage an installer who participates in and who has fulfilled requirements of the SPFA program

for company accreditation as "SPFA PCP Accredited Company Roofing," with individual applicator certification for personnel assigned to work on Project.

B. Comply with recommendations in SPFA AY-104.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof area as shown on Drawings.

a. Size: [**10 feet (3 m) by 10 feet (3 m)**]

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by manufacturer.

C. Remove and replace material that cannot be applied within its stated shelf life.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Apply materials within the range of ambient and substrate temperatures recommended in writing by material manufacturers, but not below **50 deg F (10 deg C)**.
2. Apply materials within range of relative humidity recommended in writing by manufacturer of each component, but not when relative humidity exceeds 85 percent, or when temperatures are less than **5 deg F (3 deg C)** above dew point.
3. Do not apply materials to damp or wet surfaces.
4. Do not apply primers, polyurethane foam, or coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period.
5. Do not apply polyurethane foam when wind conditions result in surface finish textures not complying with requirements.
6. Do not apply coatings when wind conditions prevent uniform coating application.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace coated foamed roofing that does not comply with requirements or that does not remain watertight within specified warranty period.

1. Warranty Period: [**Five**][**10**][**15**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**coating and polyurethane foam from single source from single manufacturer**][**coating from single source from single manufacturer and polyurethane foam from single manufacturer acceptable in writing to coating manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Coated foamed roofing to withstand exposure to weather without failure due to defective manufacture, installation, or other defects in construction. Membrane roofing to remain watertight.

1. Material Compatibility: Provide polyurethane foam, coatings, substrate board, and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Fire-Test-Response Characteristics: Provide coated foamed roofing with the fire-test-response characteristics indicated, as determined by testing identical systems in accordance with test methods below for deck type and slopes indicated by a qualified testing and inspecting agency that is acceptable to authorities having jurisdiction.

1. [**Class A**][**Class B**][**Class C**] roof covering in accordance with ASTM E108.
2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**75**] or less.

3. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM 4474, UL 580, or UL 1897.

D. FM Approvals Listing: Provide roofing system and component materials that comply with requirements in [**FM Approvals Standard 4450 for steel roof decks and**]FM Approvals Standard 4470 for roof covers as part of a foamed roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-[**60**][**75**][**90**][**105**][**120**].
2. Hail-Resistance Classification: [**MH**][**SH**].

E. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**15**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

I. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

J. Energy Star Listing: Provide coated foam roofing that is listed on the EPA/DOE's "Energy Star Roof Product List" for [**low**][**steep**]-slope roof products.

K. Energy Performance: Provide coated foamed roofing certified and labeled in accordance with one of the following when tested in accordance with ANSI/CRRC S100:

1. Three-year, aged solar reflectance of not less than [**0.55**] and emissivity of not less than [**0.75**].
2. Three-year, aged Solar Reflectance Index of not less than [**64**] when calculated in accordance with ASTM E1980.

2.3 POLYURETHANE FOAM

A. Polyurethane Foam: Rigid, cellular polyurethane; complying with ASTM C1029, [**Type III**][**Type IV**]; spray applied, with fire retardants as required, and acceptable to coating manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Conklin Company Inc**]
b. [**Gaco; Holcim Building Envelope**]
c. [**General Coatings Manufacturing Corp.**]
d. [**Huntsman Building Solutions**]
e. [**Master Builders Solutions**]
f. [**NCFI; Barnhart Manufacturing Co.**]
g. [**Neogard; Hempel Group**]
h. [**SWD Urethane Company**]
i. [**Volatile Free, Inc.**]

2. In-Place Density: **2.8 to 3.0 lb/cu. ft. (44.9 to 48.1 kg/cu. m)**; ASTM D1622/D1622M.

2.4 URETHANE COATINGS

A. Urethane Coating: Liquid urethane elastomeric coating system specifically formulated for coating spray-applied polyurethane foam roofing.[**One-component urethanes must comply with ASTM D6947/D6947M.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aldo Products Inc.**]
b. [**ER Systems; a Holcim brand**]
c. [**Gaco; Holcim Building Envelope**]
d. [**GAF**]

e. [**Master Builders Solutions**]
f. [**NCFI; Barnhart Manufacturing Co.**]
g. [**Neogard; Hempel Group**]
h. [**Volatile Free, Inc.**]

2. Base Coat: [**One**][**Two**][**One- or two**]-component urethane[**color contrasting with topcoat**].
3. Topcoat: [**One**][**Two**][**One- or two**]-component urethane.

a. Color: [**White**][**Gray**][**Tan**].
b. Color at Walkways: [**White**][**Gray**][**Tan**].

4. Tensile Strength: **600 psi (4.1 MPa)** minimum in accordance with ASTM D2370.
5. Elongation: 350 percent minimum in accordance with ASTM D412 after 1000 hours accelerated weathering in accordance with ASTM D4798/D4798M.
6. Water Absorption: 3 percent maximum by weight in accordance with ASTM D471.
7. Fungal Resistance: Zero rating in accordance with ASTM G21.
8. Tear Resistance: **100 lbf/inch (17.5 kN/m)** minimum in accordance with ASTM D624.
9. Low-Temperature Flexibility: Pass **0.5-inch (12.5-mm)** mandrel at **minus 15 deg F (minus 26 deg C)** in accordance with ASTM D522/D522M.
10. Vapor Permeance: Minimum [**0.7 perm (40.2 ng/Pa x s x sq. m)**][**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.5 SILICONE COATINGS

A. Silicone Coating: Liquid silicone elastomeric coating system[**complying with ASTM D6694/D6694M and**] specifically formulated for coating spray-applied polyurethane foam roofing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aldo Products Inc.**]
b. [**ER Systems; a Holcim brand**]
c. [**Gaco; Holcim Building Envelope**]
d. [**GAF**]
e. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
f. [**General Coatings Manufacturing Corp.**]
g. [**Huntsman Building Solutions**]
h. [**Master Builders Solutions**]
i. [**NCFI; Barnhart Manufacturing Co.**]
j. [**Neogard; Hempel Group**]
k. [**Volatile Free, Inc.**]

2. Composition: [**One**][**Two**][**One- or two**]-component silicone.
3. Base-Coat Color: Contrasting with topcoat.
4. Topcoat Color: [**White**][**Gray**][**Tan**].
5. Topcoat Color at Walkways: [**White**][**Gray**][**Tan**].
6. Vapor Permeance: Minimum [**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.6 ACRYLIC COATINGS

A. Acrylic Coating: Liquid acrylic elastomeric emulsion coating system specifically formulated for coating spray-applied polyurethane foam roofing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aldo Products Inc.**]
b. [**Conklin Company Inc**]
c. [**ER Systems; a Holcim brand**]
d. [**Gaco; Holcim Building Envelope**]
e. [**GAF**]
f. [**General Coatings Manufacturing Corp.**]
g. [**Huntsman Building Solutions**]
h. [**NCFI; Barnhart Manufacturing Co.**]
i. [**Neogard; Hempel Group**]
j. [**SWD Urethane Company**]

2. Base-Coat Color: Contrasting with topcoat.
3. Topcoat Color: [**White**][**Gray**][**Tan**].
4. Topcoat Color at Walkways: [**White**][**Gray**][**Tan**].
5. Vapor Permeance: Minimum [**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.7 SUBSTRATE BOARD

A. Gypsum Board Thermal Barrier: ASTM C1396/C1396M, [**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**] thick.

B. Thermal Barrier Board: Board product tested in accordance with and meeting the requirements of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

C. Glass Mat Gypsum Thermal Barrier: Water-resistant gypsum board with fiberglass mat laminated to both sides, ASTM C1177/C1177M, [**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**USG Corporation**]

D. Thermal-Barrier Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals Standard 4470, and designed and sized for fastening thermal barrier to substrate.

2.8 ACCESSORY MATERIALS

A. General: Accessory materials recommended in writing by roofing manufacturer for intended use.

1. Liquid-type accessory materials must comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants shall comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Primer: Polyurethane-foam manufacturer's standard factory-formulated primer.

C. Vapor Retarder: [**Fluid applied**][**Bituminous membrane**][**As recommended in writing by coated foamed roofing manufacturer**].

D. Mineral Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing **No. 8 (2.36-mm)** sieve and 98 percent of mass retained by **No. 40 (0.42-mm)** sieve.

1. Color: [**Buff white**][**Gray**][**Green**][**Red**]

E. Aggregate: Coarse mineral aggregate, **3/4 inch (19 mm)** maximum, ASTM D1863/D1863M, No. 7 or No. 67 gradation.

F. Reinforcement: Flexible polyester or fiberglass mat of weight, type, and composition recommended in writing by coating manufacturer for embedment in liquid coating.

G. Walkway Pads: Factory formed of nonwoven PVC strands, porous, UV stabilized, of **5/16-inch (8-mm)**

nominal thickness, and approved by coating manufacturer. Provide pad sizes indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Sika Greenstreak**]

2. Color: [**Yellow**][**Gray**][**Blue**][**Orange**][**Green**].

H. Sealant: ASTM C920, Class 25, Use NT, Grade NS, [**Type M, multicomponent urethane**][**Type S, one-component, neutral- or acid-curing silicone**], and as recommended in writing by coated foamed roofing manufacturer for substrate and joint conditions and for compatibility with roofing materials.

I. Sheet Flashing and Accessories: Types recommended in writing by coated foamed roofing manufacturer, provided at locations indicated and as recommended.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that related work is complete. Do not install coated foamed roofing until roof openings, curbs, and parapets, if any, are complete and roof drains, vents, and other roof penetrations are in place.

B. Examine substrates, areas, and conditions under which coated foamed roofing will be applied, with Installer present, for compliance with requirements.

C. Proceed with installation only after unsatisfactory conditions have been corrected and substrates are dry.

D. Proceed with installation only after minimum concrete curing and drying period recommended in writing by coated foamed roofing manufacturer.

E. Verify that concrete substrate is visibly dry and free of moisture. Test concrete substrate for capillary moisture by plastic sheet method in accordance with ASTM D4263[**at start of each day's work and**] at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under the plastic sheet.

3.2 INSTALLATION OF SUBSTRATE BOARD

A. General: Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

B. Thermal Barrier: [**Fasten to top flanges of steel deck in accordance with recommendations in FM Global's "Approval Guide" and its FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification**][**Fasten to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with coated foamed roofing manufacturer's written instructions**].

C. Recover Board: Install in accordance with coated foamed roofing manufacturer's written instructions and

the requirements in Section 070150.19 "Preparation for Re-Roofing." Fasten through existing roofing to roof structure as indicated. Space fasteners [**for wind-uplift conditions at Project site**][**as indicated**].

3.3 SURFACE PREPARATION

A. General: Clean and prepare substrate in accordance with coated foamed roofing manufacturer's written instructions. Provide clean, dust-free, dew-free, and dry substrate for coated foamed roofing application.

B. Remove grease, oil, form-release agents, curing compounds, and other contaminants from substrate.

C. Prepare substrate for re-covering in accordance with Section 070150.19 "Preparation for Re-Roofing" and to coated foamed roofing manufacturer's written instructions.

D. Cover and mask adjoining surfaces not receiving coated foamed roofing to prevent overspray or spillage affecting other construction. Temporarily close off roof drains, removing roof-drain plugs when not doing coated foamed roofing work or when rain is forecast.

1. Remove masking after polyurethane foam application; cover and re-mask adjoining surfaces before coating polyurethane foam.

E. Prime substrate as recommended in writing by coated foamed roofing manufacturer.

F. Fill, cover, or tape joints and cracks in substrate that exceed a width of **1/4 inch (6 mm)**. Remove dust and dirt from narrower joints and cracks before applying polyurethane foam.

G. Install vapor retarder in accordance with coated foamed roofing manufacturer's written instructions.

3.4 APPLICATION OF POLYURETHANE FOAM

A. General: Mix and apply polyurethane foam in accordance with ASTM D5469/D5469M and coated foamed roofing manufacturer's written instructions.

1. Fill irregularities and depressions to prevent ponding water.
2. Apply the required full thickness of polyurethane foam in any specific area on same day.
3. Apply only the area of polyurethane foam that can be covered with required base coating on same day or within 24 hours.
4. Apply polyurethane foam to avoid overspray beyond immediate area of work.

B. Apply polyurethane foam in lift thicknesses of not less than **1/2 inch (13 mm)** and not more than **1-1/2 inches (38 mm)**.

C. Uniformly apply total thickness of polyurethane foam indicated, but not less than **1 inch (25 mm)**, to a surface tolerance of plus **1/4 inch (6 mm)** and no minus.

1. Slope to Drain: Vary thickness uniformly and fill low spots to achieve minimum **1/4-inch-per-foot (1:48)** slope to drain unless otherwise indicated.

D. Apply polyurethane foam to roof penetrations, terminations, and vertical surfaces as indicated. Unless otherwise indicated, extend polyurethane foam at least **4 inches (100 mm)** above elevation of adjacent roof field.

E. Surface Finish: Provide finished surface of polyurethane foam within the following range of surface

textures as defined by ASTM D5469/D5469M:

1. Texture: Smooth to [**orange peel**][**coarse orange peel**][**verge of popcorn**].

F. Remove and replace polyurethane foam not complying with surface-texture limitations. Remove defective thickness and prepare and reapply polyurethane foam with acceptable, uniform results.

3.5 APPLICATION OF COATING

A. Allow polyurethane foam substrate to cure for a minimum of two hours before coating, and apply coating system to polyurethane foam no later than 24 hours after applying the foam. Remove dust, dirt, water, and other contaminants before applying coating system.

B. Apply coating system to polyurethane foam by spray, roller, or other suitable application method in accordance with coating manufacturer's written instructions.

C. Apply base coat and one or more topcoats to obtain a uniform, seamless membrane free of blisters and pinholes. Apply each coat at right angles to preceding coat, using contrasting color tints for successive coats.

1. Apply topcoat(s) after removing dust, dirt, water, and other contaminants from base coat.
2. Urethane Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 25 mils (0.64 mm)**][**of 30 mils (0.76 mm)**][**of 35 mils (0.89 mm)**].
3. Silicone Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 20 mils (0.50 mm)**][**of 22 mils (0.56 mm)**][**of 26 mils (0.66 mm)**][**of 30 mils (0.76 mm)**].
4. Acrylic Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 25 mils (0.64 mm)**][**of 28 mils (0.71 mm)**][**of 32 mils (0.81 mm)**].

D. Height at Terminations: Apply coating system at wall terminations and other vertical surfaces to extend vertically beyond polyurethane foam by a minimum of **4 inches (100 mm)**.

E. Mineral Granules: Apply mineral granules over wet topcoat, using pressure equipment at the rate of [**0.5 lb/sq. ft. (2.45 kg/sq. m)**]. Remove excess granules after topcoat has cured.

F. Sealant: Apply sealant to perimeter and other terminations where indicated on Drawings or required by coated foamed roofing manufacturer.

G. Walkways: Install roof walkways in pattern and locations indicated and as follows:

1. Granule-Coated Walkways: Mask off completed coating adjacent to walkways, and apply one or two additional topcoats to achieve a minimum dry film thickness recommended in writing by coated foamed roofing manufacturer. Spread mineral granules uniformly at a rate of **0.5 lb/sq. ft. (2.45 kg/sq. m)** into final wet coating. Remove masking and excess granules after topcoat has cured.
2. Fabric-Reinforced, Granule-Coated Walkways: Mask off completed coating adjacent to walkways, and apply one additional topcoat to achieve a minimum dry film thickness recommended in writing by coated foamed roofing manufacturer. Lay reinforcing fabric into wet coating and apply another topcoat, completely filling fabric. Spread mineral granules uniformly at a rate of **0.5 lb/sq. ft. (2.45 kg/sq. m)** into final wet coating. Remove masking and excess granules after topcoat has cured.
3. Preformed Walkway-Pad Walkways: Adhere walkway pads to substrate with compatible adhesive in accordance with coated foamed roofing manufacturer's written instructions.

H. Aggregate: Apply aggregate uniformly over coated polyurethane foam at coated foamed roofing manufacturer's recommended rate, but not less than **6 lb/sq. ft. (29 kg/sq. m)** and a minimum thickness of **3/4 inch (19 mm)**. Spread with care to prevent puncturing coating and to minimize damage to substrate foam.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing agency will identify, seal, and certify samples of materials taken from Project site, with Contractor present.
2. Testing agency will perform tests for product characteristics specified or cited in manufacturer's product data.

    a. Two core samples will be required for roof areas of up to **10,000 sq. ft. (900 sq. m)**, and one core sample will be required for each additional **10,000 sq. ft. (900 sq. m)** or part thereof.
    b. Six slit-test samples will be required for each **10,000 sq. ft. (900 sq. m)** of roof area to determine, as a minimum, the number of coats applied and dry film thickness of coating.

3. Testing agency will verify that surfaces slope to drain.

B. Coated foamed roofing will be considered defective if it does not pass tests and inspections.

C. Refill cores, repair slits, and re-coat test areas.

D. Prepare test and inspection reports.

3.7 REPAIR AND RE-COATING

A. Correct deficiencies in, or remove, foam or coatings that do not comply with requirements; fill and repair substrates and reapply materials.

B. Repair and re-coat coated foamed roofing in accordance with ASTM D6705/D6705M and manufacturer's written instructions.

3.8 CURING, PROTECTING, AND CLEANING

A. Cure coatings in accordance with manufacturer's written instructions, taking care to prevent contamination and damage during application stages and curing. Do not permit traffic on uncured coatings.

B. Protect coated foamed roofing from damage and wear during remainder of construction period.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 65 16 00A

Task	Specification	Specification Description
07 65 16 00	07 05 13 00c	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing

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SECTION 07 71 00 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Manufactured units for the following applications:

1. Copings.
2. Roof-edge specialties.
3. Roof-edge drainage systems.
4. Reglets and counterflashings.
5. Underlayment.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing embedded reglets.
2. Section 042000 "Unit Masonry" for installing embedded reglets and for masonry through-wall flashing with receiver for counterflashing.
3. Section 055000 "Metal Fabrications" for downspout guards and downspout boots.
4. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
5. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated, sheet metal flashing and trim.
6. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint cover assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.
9. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.
10. Section 099113 "Exterior Painting" for field painting of roof specialties.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect, the Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of roof specialty.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties.

1. Plans, expansion-joint locations, keyed details, and attachments to other work. Distinguish between factory pre manufactured- and field-assembled installation.
2. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Details of termination points and assemblies, including fixed points.
5. Details of special conditions.

C. Samples: For each type of roof specialty and for each color and texture specified.

D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

E. Samples for Verification:

1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
2. Include [**copings**][**roof-edge specialties**][**roof-edge drainage systems**][**reglets and counterflashings**] made from **12-inch** **(300-mm)** lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of roof specialty [**copings**][**roof-edge flashings**] that is [**ANSI/SPRI/FM 4435/ES-1 tested**][**FM Approvals approved**].

B. Product Test Reports: For [**copings**][**roof-edge flashings**], for tests performed by a qualified testing agency.

C. Research Reports: For [**copings**][**roof-edge flashings**], from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with ANSI/SPRI/FM 4435/ES-1.

D. Qualification Statements: For manufacturer.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roof specialties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products that are [**FM Approvals listed for specified class**][**ANSI/SPRI/FM 4435/ES-1 tested to specified design pressure**].

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof edge as indicated on Drawings.
2. Build mockup of typical roof edge as part of "Integrated Exterior Mockup" specified in [**Section 014000 "Quality Requirements."**]
3. Build mockup of typical roof edge, including [**fascia**][**gutter**][**downspout**], approximately [**10 ft. (3.0 m)**] long, including supporting construction, seams, attachments,[**underlayment,**] and accessories.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.10 COORDINATION

A. Coordinate roof specialties with roofing system, exterior wall system, air barrier, flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, weathertight, secure, and noncorrosive installation.

1. Performance Coordination: Coordinate with the Work of roofing and exterior wall Sections to ensure that roof specialties provided under the Work of this Section meet or exceed specified roofing and exterior wall design performance requirements.

B. Confirm and coordinate compatibility of materials and comply with warranty requirements of roofing system manufacturer.

C. Coordinate roof specialties layout and seams with sizes and locations of joints and seams in adjacent materials.

1.11 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer agrees to repair finishes or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

C. FM Approvals' Listing: Manufacture and install [**copings**][**roof-edge specialties**] that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, [**Class 1-60**][**Class 1-75**][**Class 1-90**][**Class 1-105**][**Class 1-120**]. Identify materials with FM Approvals' markings.

D. SPRI Wind Design Standard: Manufacture and install [**copings**][**roof-edge specialties**] tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressures:

1. Design Pressure: [**As indicated on Drawings**].

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 COPINGS

A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding [**12 ft. (3.6 m)**], concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Architectural Products Company**]
b. [**ATAS International, Inc.**]
c. [**Berridge Manufacturing Company**]
d. [**Castle Metal Products**]
e. [**Cheney Flashing Company**]
f. [**Drexel Metals Corp.**]
g. [**Englert, Inc.**]
h. [**EXCEPTIONAL Metals**]
i. [**FlashCo Manufacturing Inc.**]
j. [**Hickman; an MTL Company**]
k. [**Merchant & Evans Inc.**]
l. [**Metal-Era, Inc.**]
m. [**OMG Roofing Products; a Division of OMG, Inc.**]
n. [**PAC-CLAD; Petersen; a Carlisle company**]
o. [**SAF (Southern Aluminum Finishing Company, Inc.)**]
p. [**Sentrigard; NB Handy Company**]

2. Metallic-Coated Steel Coping Caps: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal [**0.028-inch (0.71-mm) thickness**][**0.034-inch (0.86-mm) thickness**][**thickness as required to meet performance requirements**].

   a. Surface: [**Smooth, flat**][**Embossed**] finish.
   b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Formed Aluminum Coping Caps: Aluminum sheet, [**0.040 inch (1.02 mm) thick**][**0.050 inch (1.27 mm) thick**][**0.063 inch (1.60 mm) thick**][**thickness as required to meet performance requirements**].

   a. Surface: [**Smooth, flat**][**Embossed**] finish.
   b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
   c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Extruded-Aluminum Coping Caps: Extruded aluminum, [**0.080 inch (2.03 mm) thick**][**0.125 inch (3.18 mm) thick**][**thickness as required to meet performance requirements**].

   a. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
   b. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Formed Stainless Steel Coping Caps: Stainless steel sheet, nominal [**0.0313-inch (0.795-mm) thickness**][**thickness as required to meet performance requirements**].

   a. Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled)**][**ASTM A480/A480M No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4 (bright, polished directional satin)**].

6. Formed Copper Coping Caps: Copper sheet, [16 oz./sq. ft. (0.55 mm)][20 oz./sq. ft. (0.68 mm)][24 oz./sq. ft. (0.82 mm)][**Thickness as required to meet performance requirements**].

    a. Copper Finish: [**Non-patinated, mill**][**Pre-patinated dark brown**][**Pre-patinated verdigris**].

7. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
8. Special Fabrications: [**Radiused sections**][**Arched sections**][**Bullnose-face leg**][**Two-way sloped coping cap**].
9. Coping-Cap Attachment Method: [**Snap-on**][**face leg hooked to continuous cleat with back leg fastener exposed**], fabricated from coping-cap material.

    a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.
    b. Face-Leg Cleats: Concealed, continuous [**galvanized-steel sheet**][**stainless steel**].

2.3 ROOF-EDGE SPECIALTIES

A. Canted Roof-Edge Fascia and Gravel Stop : Manufactured, two-piece, roof-edge fascia consisting of [**snap-on**][**compression-clamped**] metal fascia cover in section lengths not exceeding [12 ft. (3.6 m)] and a continuous formed galvanized-steel sheet cant, 0.028 inch (0.71 mm) thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Products Company**]
    b. [**ATAS International, Inc.**]
    c. [**Berridge Manufacturing Company**]
    d. [**Castle Metal Products**]
    e. [**Cheney Flashing Company**]
    f. [**Drexel Metals Corp.**]
    g. [**Englert, Inc.**]
    h. [**FlashCo Manufacturing Inc.**]
    i. [**Merchant & Evans Inc.**]
    j. [**Metal-Era, Inc.**]
    k. [**OMG Roofing Products; a Division of OMG, Inc.**]
    l. [**PAC-CLAD; Petersen; a Carlisle company**]
    m. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

2. Metallic-Coated Steel Fascia Covers: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal [0.028-inch (0.71-mm) **thickness**][0.034-inch (0.86-mm) **thickness**][**thickness as required to meet performance requirements**].

    a. Surface: [**Smooth, flat**][**Embossed**] finish.
    b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
    c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Formed Aluminum Fascia Covers: Aluminum sheet, [**0.040 inch (1.02 mm) thick**][**0.050 inch (1.27 mm) thick**][**0.063 inch (1.60 mm) thick**][**thickness as required to meet performance requirements**].

    a. Surface: [**Smooth, flat**][**Embossed**] finish.
    b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
    c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Extruded-Aluminum Fascia Covers: Extruded aluminum, [**0.080 inch (2.03 mm) thick**][**0.125 inch (3.18 mm) thick**][**thickness as required to meet performance requirements**].

    a. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
    b. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
6. Splice Plates: [**Concealed**][**Exposed**], of same material, finish, and shape as fascia cover.
7. Special Fabrications: [**Radiused sections**][**Arched sections**][**Bullnose fascia cover**][**Cornice fascia cover**][**Cove fascia cover**].
8. Fascia Accessories: [**Fascia extenders with continuous hold-down cleats**][**Wall cap**][**Soffit trim**][**Overflow scuppers**][**Overflow scuppers with perforated screens**][**Spillout scuppers**][**Downspout scuppers with integral conductor head and downspout adapters**][**Downspout scuppers with integral conductor head and downspout adapters and perforated screens**].

B. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding [**12 ft. (3.6 m)**] and a continuous metal receiver with integral drip-edge cleat to engage fascia cover[**and secure single-ply roof membrane**]. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ATAS International, Inc.**]
    b. [**Berridge Manufacturing Company**]
    c. [**Drexel Metals Corp.**]
    d. [**Englert, Inc.**]
    e. [**EXCEPTIONAL Metals**]
    f. [**Fabral; a brand of Flack Global Metals**]
    g. [**FlashCo Manufacturing Inc.**]
    h. [**Hickman; an MTL Company**]
    i. [**Metal-Era, Inc.**]
    j. [**OMG Roofing Products; a Division of OMG, Inc.**]

2. Metallic-Coated Steel Fascia Covers: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal [**0.028-inch (0.71-mm) thickness**][**0.034-inch (0.86-mm) thickness**][**thickness as required to meet performance requirements**].

a. Surface: [**Smooth, flat**][**Embossed**] finish.
b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Formed Aluminum Fascia Covers: Aluminum sheet, [**0.040 inch (1.02 mm) thick**][**0.050 inch (1.27 mm) thick**][**0.063 inch (1.60 mm) thick**][**thickness as required to meet performance requirements**].

a. Surface: [**Smooth, flat**][**Embossed**] finish.
b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
5. Splice Plates: [**Concealed**][**Exposed**], of same material, finish, and shape as fascia cover.
6. Receiver: [**Galvanized-steel sheet, nominal 0.040-inch (1.02-mm) thickness**][**Aluminum sheet, 0.050 inch (1.27 mm) thick**][**Extruded aluminum, 0.080 inch (2.03 mm) thick**][**Manufacturer's standard material and thickness**].
7. Special Fabrications: [**Radiused sections**][**Arched sections**][**Bullnose fascia cover**][**Cornice fascia cover**][**Cove fascia cover**].
8. Fascia Accessories: [**Fascia extenders with continuous hold-down cleats**][**Wall cap**][**Soffit trim**][**Overflow scuppers**][**Overflow scuppers with perforated screens**][**Spillout scuppers**][**Downspout scuppers with integral conductor head and downspout adapters**][**Downspout scuppers with integral conductor head and downspout adapters and perforated screens**].

C. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding [**12 ft. (3.6 m)**], with a horizontal flange and vertical leg[**drain-through**] fascia[**terminating in a drip edge**], and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Products Company**]
b. [**Berridge Manufacturing Company**]
c. [**Castle Metal Products**]
d. [**Cheney Flashing Company**]
e. [**Drexel Metals Corp.**]
f. [**OMG Roofing Products; a Division of OMG, Inc.**]
g. [**PAC-CLAD; Petersen; a Carlisle company**]
h. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

2. Metallic-Coated Steel Gravel Stops: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal [**0.028-inch (0.71-mm) thickness**][**0.034-inch (0.86-mm) thickness**][**thickness as required to meet performance requirements**].

a. Surface: [**Smooth, flat**][**Embossed**] finish.
b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Formed Aluminum Gravel Stops: Aluminum sheet, [**0.040 inch (1.02 mm) thick**][**0.050 inch (1.27 mm) thick**][**0.063 inch (1.60 mm) thick**][**thickness as required to meet performance requirements**].

a. Surface: [**Smooth, flat**][**Embossed**] finish.
b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Extruded-Aluminum Gravel Stops: Extruded aluminum, [**0.080 inch (2.03 mm) thick**][**0.125 inch (3.18 mm) thick**][**thickness as required to meet performance requirements**].

a. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
b. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Formed Stainless Steel Gravel Stops: Stainless steel sheet, nominal [**0.0313-inch (0.795-mm) thickness**][**thickness as required to meet performance requirements**].

a. Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled)**][**ASTM A480/A480M No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4 (bright, polished directional satin)**].

6. Formed Copper Gravel Stops: Copper sheet, [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].

a. Copper Finish: [**Non-patinated, mill**][**Pre-patinated dark brown**][**Pre-patinated verdigris**].

7. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
8. Accessories: [**Fascia extenders with continuous hold-down cleats**][**Wall cap**][**Soffit trim**].

2.4 ROOF-EDGE DRAINAGE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Architectural Products Company**]
2. [**ATAS International, Inc.**]
3. [**Berger; division of OmniMax International, Inc.**]
4. [**Castle Metal Products**]
5. [**Cheney Flashing Company**]

6. [**CopperCraft by Fabral**]
7. [**Drexel Metals Corp.**]
8. [**EXCEPTIONAL Metals**]
9. [**Hickman; an MTL Company**]
10. [**Merchant & Evans Inc.**]
11. [**Metal-Era, Inc.**]
12. [**OMG Roofing Products; a Division of OMG, Inc.**]
13. [**RDCA; Roof Drainage Components & Accessories**]
14. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

B. Gutters: Manufactured in uniform section lengths not exceeding [**12 ft. (3.6 m)**], with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least **1 inch (25 mm)** above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**][**0.034-inch (0.86-mm)**].
2. Formed Aluminum Sheet: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] thick.
3. Formed Copper Sheet: [**16-oz./sq. ft. (0.55-mm)**][**20-oz./sq. ft. (0.68-mm)**][**24-oz./sq. ft. (0.82-mm)**] thickness.
4. Gutter Profile: [**Style A**][**Style B**][**Style F**][**Style G**][**Style H**][**Style I**][**Style K**][**Style K highback**][**Half-round single bead**][**Half-round highback**][**Quarter round**][**Ogee**][**As indicated**] in accordance with SMACNA's "Architectural Sheet Metal Manual."
5. Embossed Surface: Embossed with design [**as indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**].
6. Applied Fascia Cover (Concealed Gutter): Exposed, formed [**copper, 16 oz./sq. ft. (0.55 mm thick)**][**aluminum, 0.040 inch (1.02 mm) thick**], with factory-mitered corners, ends, and concealed splice joints.
7. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
8. Gutter Supports: [**Gutter brackets**][**Straps**][**Spikes and ferrules**][**Manufacturer's standard supports as selected by Architect**] with finish matching the gutters.
9. Special Fabrications: [**Radiused sections**].
10. Gutter Accessories: [**Continuous screened leaf guard with sheet metal frame**][**Continuous hinged leaf guard of solid metal designed to shed leaves**][**Continuous snap-in plastic leaf guard**][**Bronze wire ball downspout strainer**][**Wire ball downspout strainer**][**Flat ends**][**Bullnose ends for half-round gutter**].

C. Downspouts: [**Plain round**][**Corrugated round**][**Plain rectangular**][**Corrugated rectangular**][**Open-face rectangular**] complete with [**machine-crimped**][**mitered**][**smooth-curve**] elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**][**0.034-inch (0.86-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] thick.
3. Extruded Aluminum: [**0.125 inch (3.18 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Size: [**As indicated on Drawings**].

D. Parapet Scuppers: Manufactured with closure flange trim to exterior, **4-inch- (100-mm-)** wide wall flanges to interior, and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof.[**Fasten gravel guard angles to base of scuppers.**]

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.032 inch (0.81 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0188 inch (0.477 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Size: [**As indicated on Drawings**].

E. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge, and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout[**exterior flange trim,**][**built-in overflow**].

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.032 inch (0.81 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0156 inch (0.396 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Size: [**As indicated on Drawings**].

F. Splash Pans: Fabricate from the following exposed metal:

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.040 inch (1.02 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0188 inch (0.477 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Size: [**As indicated on Drawings**].

G. Finishes:

1. Metallic-Coated Steel: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Aluminum: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
    a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Stainless Steel: [**ASTM A480/A480M No. 2B (bright, cold rolled, unpolished)**][**ASTM A480/A480M No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4 (bright, polished directional satin)**].
4. Copper: [**Non-patinated, mill**][**Pre-patinated dark brown**][**Pre-patinated verdigris**].

2.5 REGLETS AND COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ATAS International, Inc.**]
2. [**Berridge Manufacturing Company**]

3. [**Castle Metal Products**]
4. [**Cheney Flashing Company**]
5. [**Drexel Metals Corp.**]
6. [**EXCEPTIONAL Metals**]
7. [**Fry Reglet Corporation**]
8. [**Heckmann Building Products, Inc.**]
9. [**Hickman; an MTL Company**]
10. [**Keystone Flashing Company, Inc**]
11. [**Metal-Era, Inc.**]
12. [**OMG Roofing Products; a Division of OMG, Inc.**]

B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:

1. Metallic-Coated Steel Sheet: Nominal [**0.022-inch (0.56-mm)**][**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.024 inch (0.61 mm)**][**0.050 inch (1.27 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
6. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
7. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
8. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
9. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
10. Multiuse Type, Embedded: For multiuse embedment in [**cast-in-place concrete**][**masonry mortar joints**].

C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by **4 inches (100 mm)** and in lengths not exceeding [**12 ft. (3.6 m)**] designed to snap into [**reglets**][**through-wall-flashing receiver**] and compress against base flashings with joints lapped, from the following exposed metal:

1. Metallic-Coated Steel Sheet: Nominal [**0.022-inch (0.56-mm)**][**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].

D. Accessories:

1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

E. Finishes:

1. Metallic-Coated Steel: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Aluminum: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].

    a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel: [**ASTM A480/A480M No. 2B (bright, cold rolled, unpolished)**][**ASTM A480/A480M No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4 (bright, polished directional satin)**].
4. Copper: [**Non-patinated, mill**][**Pre-patinated verdigris**].

2.6 SHEET METAL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality.[**Mill phosphatized for field painting where indicated**].

1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil (0.005 mm)**.
3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight in color coat.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

B. Aluminum Sheet: ASTM B209/B209M, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: As manufactured.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil (0.005 mm)**.
3. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
4. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.
5. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight in color coat.

6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Extrusions and Tubes: **ASTM B221 (ASTM B221M)**, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise, mill finished.

D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

E. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

2.7 UNDERLAYMENT

A. Synthetic Underlayment: Provide laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures greater than **220 deg F (111 deg C)**; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATAS International, Inc.**]
b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
c. [**GCP Applied Technologies Inc.**]
d. [**Kirsch Building Products**]
e. [**Owens Corning**]
f. [**Palisade; Brand of Intertape Polymer Group (IPG)**]

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum **30 mils (0.76 mm)** thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at **240 deg F (116 deg C)**; ASTM D1970/D1970M.
2. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)** or lower; ASTM D1970/D1970M.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATAS International, Inc.**]
b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
c. [**GCP Applied Technologies Inc.**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**Palisade; Brand of Intertape Polymer Group (IPG)**]

f. [**Polyglass U.S.A., Inc.**]
g. [**Protecto Wrap Company**]

C. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

D. Slip Sheet: Rosin-sized building paper, **3-lb/100 sq. ft. (0.16-kg/sq. m)** minimum.

2.8 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Roof specialty manufacturer's recommended fasteners, designed to meet performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
4. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
5. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

C. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

D. Elastomeric Sealant: ASTM C920, elastomeric [**polyurethane**][**silicone**] polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

G. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

H. Solder for Copper: ASTM B32, [**lead-free solder**][**Grade Sn50, 50 percent tin and 50 percent lead**].

2.9 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than **4 inches (100 mm)**.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than **2 inches (50 mm)**.

D. Slip Sheet: Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than **4 inches (100 mm)**.

3.3 INSTALLATION, GENERAL

A. Install roof specialties in accordance with manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete

roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer's written installation instructions.

1. Coat concealed side of [**uncoated aluminum**][**stainless steel**] roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of [**12 ft. (3.6 m)**] with no joints within [**18 inches (450 mm)**] of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws**][**substrate not less than recommended in writing by fastener manufacturer to achieve maximum pull-out resistance**].

E. Seal concealed joints with butyl sealant as required by roof specialty manufacturer.

F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below **40 deg F (4 deg C)**.

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of **1-1/2 inches (38 mm)**; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 INSTALLATION OF COPINGS

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at [**30-inch (762-mm) centers**][**40-inch (1016-mm) centers**][**manufacturer's required spacing that meets performance requirements**].
2. Interlock face-leg drip edge into continuous cleat anchored to substrate at [**24-inch (610-mm)**

centers][**16-inch (406-mm) centers**][**manufacturer's required spacing that meets performance requirements**]. Anchor back leg of coping with screw fasteners and elastomeric washers at [**24-inch (610-mm) centers**][**16-inch (406-mm) centers**][**manufacturer's required spacing that meets performance requirements**].

3.5 INSTALLATION OF ROOF-EDGE SPECIALTIES

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.6 INSTALLATION OF ROOF-EDGE DRAINAGE SYSTEMS

A. Install components to produce a complete roof-edge drainage system in accordance with manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**] apart. Attach ends with rivets and [**seal with sealant**][**solder**] to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding [**50 ft. (15.2 m)**] apart. Install expansion-joint caps.
2. Install continuous leaf guards on gutters with noncorrosive fasteners, [**removable**][**hinged to swing open**] for cleaning gutters.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and **1 inch (25 mm)** away from walls; locate fasteners at top and bottom and at approximately [**60 inches (1500 mm)**] o.c.

1. Provide elbows at base of downspouts at grade to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

D. Splash Pans: Install where downspouts discharge on [**low-slope roofs**]. Set in [**asphalt roofing cement**][**elastomeric sealant**].

E. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.

1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
2. Loosely lock front edge of scupper with conductor head.
3. Seal or solder exterior wall scupper flanges into back of conductor head.

F. Conductor Heads: Anchor securely to wall with elevation of conductor top edge **1 inch (25 mm)** below [**scupper**][**gutter**] discharge.

3.7 INSTALLATION OF REGLETS AND COUNTERFLASHINGS

A. Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Embedded Reglets: See [**Section 033000 "Cast-in-Place Concrete"**][**Section 042000 "Unit Masonry"**] for installation of reglets.

C. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap **4 inches (100 mm)** over top edge of base flashings.

D. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap **4 inches (100 mm)** over top edge of base flashings. Lap counterflashing joints a minimum of **4 inches (100 mm)** and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.8 CLEANING AND PROTECTION

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Section 099113 "Exterior Painting."

C. Clean and neutralize flux materials. Clean off excess solder and sealants.

D. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

E. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as directed by the Owner.

END OF SECTION 07 71 00 00

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Task	Specification	Specification Description
07 71 13 00	07 71 00 00	Roof Specialties
07 71 19 00	07 71 00 00	Roof Specialties
07 71 23 00	01 11 19 00	No Specification Required
07 71 23 00	07 62 00 00	Sheet Metal Flashing And Trim
07 71 23 00	07 71 00 00	Roof Specialties
07 71 26 00	07 62 00 00	Sheet Metal Flashing And Trim
07 71 26 00	07 71 00 00	Roof Specialties

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SECTION 07 72 00 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Manufactured units for the following applications:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.
4. Heat and smoke vents.
5. Gravity ventilators.
6. Pipe and duct supports.
7. Pipe portals.
8. Preformed flashing sleeves.
9. Roof walkways.
10. Underlayment.
11. Miscellaneous materials.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 061000 "Rough Carpentry" for roof cants, nailers, blocking, and other pressure-preservative-treated wood.
3. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashing.
4. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.
5. Section 079200 "Joint Sealants" for field-applied sealants between roof accessories and adjacent materials.
6. Section 099113 "Exterior Painting" for field painting of roof accessories.
7. Section 099114 "Exterior Painting (MPI Standards)" for field painting of roof accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples for Initial Selection: For each type of roof accessory indicated with factory-applied color finishes.

D. Samples for Verification: Include Samples of each type of roof accessory to verify finish and color

selection, in manufacturer's standard sizes.

E. Delegated Design Submittals: For roof curbs [**roof walkways,**][**and equipment supports**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items, including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Qualification Statements: For [**manufacturer**][**fabricator**][**Installer**][**specialist**][**testing agency**][**manufacturer's technical representative**][**factory-authorized service representative**].

C. Delegated Design Engineer Qualifications: For roof curbs [**roof walkways**][**and**][**equipment supports**] .

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**roof hatches**][**heat and smoke vents**][**and gravity ventilators**] .

1.5 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof accessories in contact with other materials that might cause staining, denting, or other surface damage. Store roof accessories in accordance with manufacturer's instructions.

B. Store materials off ground in dry location and in accordance with manufacturer's instructions in well-ventilated area.

C. Store and protect roof accessories from nicks, scratches, and blemishes.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-accessory substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate layout and installation of roof accessories with [**roofing membrane and base flashing and**] interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof curbs [**roof walkways,**][**and equipment supports**] to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Wind-Restraint Performance: [**As indicated on Drawings**].

2.2 ROOF CURBS

A. Roof Curb : Internally reinforced roof-curb unit capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AES Industries, Inc**]
b. [**AES Sunoptics; Acuity Brands International, Inc.**]
c. [**Air Balance; MESTEK, Inc.**]
d. [**ATAS International, Inc.**]
e. [**Conn-Fab Sales, Inc**]
f. [**Curbs Plus, Inc**]
g. [**Custom Solution Roof and Metal Products, a division of Colony Heating**]
h. [**Greenheck Fan Corporation**]
i. [**KCC Manufacturing**]
j. [**Lloyd Industries, Inc.**]
k. [**LMCurbs**]

l. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
m. [**Metallic Products Corporation**]
n. [**Pate Company (The)**]
o. [**Plenums of Florida Incorporated**]
p. [**RCS Fabrications Inc.**]
q. [**Roof Products and Systems (RPS); Duravent Group**]
r. [**Roof Products, Inc.**]
s. [**Thybar Corporation**]
t. [**Vent Products Co., Inc**]

2. Corner Joints: Welded [**or mechanically fastened and sealed**] .
3. Curb Sides: [**Straight**][**Integral metal cant**][**Stepped integral metal cant to raise the thickness of roof insulation**] and integrally formed deck-mounting flange at perimeter bottom.
4. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

5. Supported Load Capacity: [**Coordinate load capacity with information on Shop Drawings of equipment to be supported**].

6. Steel: [**Zinc-coated (galvanized)**][**Aluminum-zinc alloy-coated**] steel sheet, [**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**][**0.079 inch (2.01 mm)**] thick.

   a. Finish: [**Mill phosphatized**][**Factory prime coating**][**Powder coat**].

   b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

7. Aluminum: [**0.090 inch (2.28 mm)**][**0.125 inch (3.17 mm)**] thick sheet.

   a. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

   b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

8. Stainless Steel: [**0.0781 inch (1.983 mm)**] thick sheet.

   a. Finish: [**Manufacturer's standard**].

9. Fabrication:

   a. Curb Profile: [**Manufacturer's standard**][**Profile as indicated on Drawings**] compatible with roofing system.
   b. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.

   c. Minimum Height: Fabricate curbs to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.
   d. Top Surface: Level top of curb, with roof slope accommodated [**by sloping deck-mounting flange**][**by use of leveler frame**] .
   e. Sloping Roofs: Where roof slope exceeds **1/4 inch per 12 inches (1:48)**, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.

f. Insulation: Factory insulated with [1-1/2-inch- (38-mm-)] thick glass-fiber board insulation.

g. Liner: Same material as curb, of manufacturer's standard thickness and finish.

h. Nailer: Factory-installed wood nailer [**along top flange of curb**][**under top flange on side of curb**] , continuous around curb perimeter.

i. Wind-Restraint Straps and Base Flange Attachment: Provide wind-restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to comply with wind-uplift requirements.

j. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- (19-mm-) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.

k. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

l. Security Grille: [**Provide for all units**][**Provide where indicated**] .

m. Damper Tray: Provide damper tray or shelf with opening [3 inches (76 mm)][**less than interior curb dimensions indicated**][**of size indicated**] .

2.3 EQUIPMENT SUPPORTS

A. Equipment Support : Metal equipment support capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AES Industries, Inc**]
b. [**Air Balance; MESTEK, Inc.**]
c. [**Conn-Fab Sales, Inc**]
d. [**Curbs Plus, Inc**]
e. [**Greenheck Fan Corporation**]
f. [**JL Industries; Activar Construction Products Group, Inc.**]
g. [**KCC Manufacturing**]
h. [**Lloyd Industries, Inc.**]
i. [**LMCurbs**]
j. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
k. [**Pate Company (The)**]
l. [**Plenums of Florida Incorporated**]
m. [**Portals Plus; Duravent Group**]
n. [**RCS Fabrications Inc.**]
o. [**Roof Products and Systems (RPS); Duravent Group**]
p. [**Roof Products, Inc.**]
q. [**Thybar Corporation**]
r. [**Vent Products Co., Inc**]

2. Type: [**Internally reinforced perimeter**][**Rail type**] .

3. Corner Joints: Welded [**or mechanically fastened and sealed**] .
4. Curb Sides: [**Integral metal cant**][**Stepped integral metal cant to raise the thickness of roof insulation**] and integrally formed structure-mounting flange at bottom.
5. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

6. Supported Load Capacity: [**Coordinate load capacity with information on Shop Drawings of equipment to be supported**].

7. Steel: [**Zinc-coated (galvanized)**][**Aluminum-zinc alloy-coated**] steel sheet, [**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**][**0.079 inch (2.01 mm)**] thick.

    a. Finish: [**Mill phosphatized**][**Factory prime coating**][**Powder coat**].

    b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

8. Aluminum: [**0.090 inch (2.28 mm)**][**0.125 inch (3.17 mm)**] thick sheet.

    a. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

    b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

9. Stainless Steel: [**0.0781 inch (1.983 mm)**] thick sheet.

    a. Finish: [**Manufacturer's standard**].

10. Construction:

    a. Curb Profile: [**Manufacturer's standard**][**Profile as indicated on Drawings**] compatible with roofing system.

    b. Insulation: Factory insulated with [**1-1/2-inch- (38-mm-)**] thick glass-fiber board insulation.

    c. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.

    d. Nailer: Factory-installed continuous wood nailers [**3-1/2 inches (90 mm)**][**5-1/2 inches (140 mm)**] wide [**on top flange of equipment supports**][**under top flange on side of curb**], continuous around support perimeter.

    e. Wind-Restraint Straps and Base Flange Attachment: Provide wind-restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to comply with wind-uplift requirements.

    f. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from **3/4-inch- (19-mm-)** thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
    g. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
    h. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.

i. Fabricate equipment supports to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.
j. Sloping Roofs: Where roof slope exceeds **1/4 inch per 12 inches (1:48)**, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

k. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .

2.4 ROOF HATCHES

A. Roof Hatch : Metal roof-hatch unit with lid and insulated curbs, continuous lid-to-curb counterflashing, and weathertight perimeter gasketing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ACUDOR Products, Inc**]
b. [**AES Industries, Inc**]
c. [**Architectural Specialties, Inc.**]
d. [**Babcock-Davis**]
e. [**Best Access Doors**]
f. [**BILCO Company (The)**]
g. [**Dur-Red Products**]
h. [**JL Industries; Activar Construction Products Group, Inc.**]
i. [**Karp Associates, Inc**]
j. [**KCC Manufacturing**]
k. [**Kingspan Light + Air LLC**]
l. [**Lexcor; a division of Luxsuco corp.**]
m. [**Metallic Products Corporation**]
n. [**Milcor by Duravent; Duravent Group.**]
o. [**Nystrom, Inc.**]
p. [**O'Keeffe's Inc.**]
q. [**Pate Company (The)**]
r. [**Precision Ladders, LLC**]
s. [**Williams Brothers Corporation of America**]

2. Insulated Curb Type: [**Single**][**Double**] walled.
3. Corner Joints: Welded [**or mechanically fastened and sealed**] .
4. Curb Sides: [**Straight**][**Integral metal cant**][**Stepped integral metal cant to raise the thickness of roof insulation**] and integrally formed structure-mounting flange at bottom.
5. Type and Size:

a. Single-Leaf Lid: [**Size as indicated on Drawings**][**30 by 36 inches (750 by 900 mm)**][**36 by 36 inches (900 by 900 mm)**][**30 by 54 inches (750 by 1370 mm)**][**30 by 96 inches (750 by 2438 mm)**].
b. Double-Leaf Lid: [**Size as indicated on Drawings**][**72 by 96 inches (1830 by 2438 mm)**].

6. Loads: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**20 lbf/sq. ft. (0.95 kPa)**] internal uplift load.

a. Dome Glazing: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**20 lbf/sq. ft.**

(0.95 kPa)] internal uplift load.

7. Hatch Material, Steel: [**Zinc-coated (galvanized)**][**Aluminum-zinc alloy-coated**] steel sheet.

   a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.079 inch (2.01 mm)**].

   b. Finish: [**Mill phosphatized**][**Factory prime coating**][**Powder coat**].

   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

8. Hatch Material, Aluminum:

   a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.079 inch (2.01 mm)**].
   b. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

9. Hatch Material, Stainless Steel:

   a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.0781 inch (1.983 mm)**].
   b. Finish: [**Manufacturer's standard**].

10. Construction:

    a. Insulation: [**1-inch- (25-mm-) thick, cellulosic-fiber board**][**1-inch- (25-mm-) thick, glass-fiber board**][**2-inch- (50-mm-) thick, polyisocyanurate board**] .

       1) R-Value: [**2.78**][**4.3**][**12.0**] in accordance with ASTM C1363.

    b. Nailer: Factory-installed wood nailer continuous around hatch perimeter.

    c. Hatch Lid: [**Opaque**][**Glazed**] , insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.

    d. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
    e. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.

    f. Fabricate curbs to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.
    g. Sloping Roofs: Where slope or roof deck exceeds **1/4 inch per 12 inches (1:48)**, fabricate curb with perimeter curb height that is [**constant**][**tapered to accommodate roof slope so that top surfaces of perimeter curb are level**] . Equip hatch with water diverter or cricket on side that obstructs water flow.

11. Hatch-Lid Glazing: [**Single**][**Double**][**acrylic**][**polycarbonate**] glazing of thickness capable of resisting indicated loads.

    a. Single-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted,**

transparent][**Bronze tinted, transparent**].

b. Outer Double-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].
c. Inner Double-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].

12. Hardware: Spring operators, hold-open arm, [**galvanized**][**stainless**] steel spring latch with turn handles, [**galvanized**][**stainless**] steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

a. Provide two-point latch on lids larger than **84 inches (2130 mm)**.
b. Provide remote-control operation.

13. Safety Railing System: Roof-hatch manufacturer's standard system, including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

a. Height: [**42 inches (1060 mm)**] above finished roof deck.

b. Posts and Rails: Galvanized-steel pipe, **1-1/4 inches (31 mm)** in diameter or galvanized-steel tube, **1-5/8 inches (41 mm)** in diameter.
c. Flat Bar: Galvanized steel, **2 inches (50 mm)** high by **3/8 inch (9 mm)** thick.

d. Maximum Opening Size: System constructed to prevent passage of a sphere **21 inches (533 mm)** in diameter.

e. Chain Passway Barrier: Galvanized proof coil chain with quick link on fixed end.
f. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
g. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
h. Provide weep holes or another means to drain-entrapped water in hollow sections of handrail and railing members.
i. Fabricate joints exposed to weather to be watertight.
j. Fasteners: Manufacturer's standard, finished to match railing system.
k. Finish: [**Manufacturer's standard**].

1) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

14. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.

a. Operation: Post locks in place on full extension; release mechanism returns post to closed position.

b. Height: [**42 inches (1060 mm)**] above finished roof deck.
c. Material: [**Steel tube**][**Stainless steel**][**Aluminum**] .

d. Post: [**1-5/8-inch- (41-mm-)**] diameter pipe.
e. Finish: [**Manufacturer's standard**].

1) Color: [**As indicated by manufacturer's designations**][**Match Architect's**

sample][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.5 HEAT AND SMOKE VENTS

A. Hatch-Type Heat and Smoke Vent : Manufacturer's standard, with insulated curbs, integral condensation gutter, and cap flashing. Fabricate with insulated double-walled lid and continuous weathertight perimeter lid gaskets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACUDOR Products, Inc**]
   b. [**AES Sunoptics; Acuity Brands International, Inc.**]
   c. [**Babcock-Davis**]
   d. [**BILCO Company (The)**]
   e. [**Dur-Red Products**]
   f. [**JL Industries; Activar Construction Products Group, Inc.**]
   g. [**KCC Manufacturing**]
   h. [**Kingspan Light + Air LLC**]
   i. [**Lexcor; a division of Luxsuco corp.**]
   j. [**Milcor by Duravent; Duravent Group.**]
   k. [**Nystrom, Inc.**]
   l. [**O'Keeffe's Inc.**]
   m. [**Pate Company (The)**]

2. Insulated Curb Type: [**Single**][**Double**] walled.
3. Corner Joints: Welded [**or mechanically fastened and sealed**] .
4. Operation: Automatic self-lifting mechanisms activated by [**UL-listed fusible link rated at 165 deg F (74 deg C)**][**fire-suppression system**][**smoke-detection system**] locking the fully opened position.
5. Type and Size:

   a. Single-Leaf Lid: [**Size as indicated on Drawings**][**30 by 36 inches (750 by 900 mm)**][**30 by 54 inches (750 by 1370 mm)**][**30 by 96 inches (750 by 2438 mm)**].
   b. Double-Leaf Lid: [**Size as indicated on Drawings**][**72 by 96 inches (1830 by 2438 mm)**].

6. Loads: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**30 lbf/sq. ft. (1.4 kPa)**] internal uplift load.

   a. When release is actuated, lid to open against [**10 lbf/sq. ft. (0.5 kPa)**] snow or wind load and lock in position.

   b. Hatch-Lid Glazing: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**20 lbf/sq. ft. (0.95 kPa)**] internal uplift load.

7. Heat and Smoke Vent Standard: Provide units that have been tested and [**listed to comply with ANSI/CAN/UL 793**][**and**][**are FM Approved**] .

8. Curb, Framing, and Lid Material, Steel: [**Zinc-coated (galvanized)**][**Aluminum-zinc alloy-**

coated] steel sheet.

a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.079 inch (2.01 mm)**] .

b. Finish: [**Mill phosphatized**][**Factory prime coating**][**Powder coat**].

c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

9. Curb, Framing, and Lid Material, Aluminum:

a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.079 inch (2.01 mm)**].

b. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

10. Construction:

a. Insulation: [**1-inch- (25-mm-) thick, cellulosic-fiber board**][**1-inch- (25-mm-) thick, glass-fiber board**][**2-inch- (50-mm-) thick, polyisocyanurate board**] .

1) R-Value: [**2.78**][**4.3**][**12.0**] in accordance with ASTM C1363.

b. Nailer: Factory-installed wood nailer continuous around hatch perimeter.

c. Hatch Lid: [**Opaque**][**Glazed**] , insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.

d. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.

e. Fabricate curbs to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.

f. Sloping Roofs: Where slope or roof deck exceeds **1/4 inch per 12 inches (1:48)**, fabricate curb with perimeter curb height that is [**constant**][**tapered to accommodate roof slope so that top surfaces of perimeter curb are level**] . Equip hatch with water diverter or cricket on side that obstructs water flow.

g. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .

11. Hatch-Lid Glazing: [**Single**][**Double**][**acrylic**][**polycarbonate**] glazing of thickness capable of resisting indicated loads; [**colorless, transparent**][**white, translucent**].

12. Hardware: Manufacturer's standard [**corrosion resistant**][**stainless steel**] ; with hinges, hold-open devices, and independent manual-release devices for [**inside**][**and**][**outside**] operation of lids.

B. Dropout-Type Heat and Smoke Vent: Manufacturer's standard, gravity operated and automatic; with insulated curbs and frame, integral condensation gutter, cap flashing, and heat-sensitive dome glazing that will deform and drop out of vent opening in accordance with heat and smoke vent standard indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Construction Specialties, Inc.**]
b. [**Kingspan Light + Air LLC**]
c. [**Pate Company (The)**]
d. [**Plasteco, Inc**]

2. Insulated Curb Type: [**Single**][**Double**] walled.
3. Corner Joints: Welded [**or mechanically fastened and sealed**] .
4. Size: [**As indicated on Drawings**][**48 by 48 inches (1219 by 1219 mm)**][**48 by 60 inches (1219 by 1524 mm)**][**48 by 72 inches (1219 by 1829 mm)**][**48 by 90 inches (1219 by 2286 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

5. Loads: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**30 lbf/sq. ft. (1.4 kPa)**] internal uplift load.

   a. Dome Glazing: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**20 lbf/sq. ft. (0.95 kPa)**] internal uplift load.

6. Heat and Smoke Vent Standard: Provide units that have been tested and [**listed to comply with ANSI/CAN/UL 793**][**and**][**are FM Approved**] .
7. Curb and Framing Material: Aluminum sheet.

   a. Thickness: [**Manufacturer's standard thickness for vent size indicated**][**0.079 inch (2.01 mm)**].
   b. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

8. Construction:

   a. Insulation: Manufacturer's standard.

   b. Nailer: Factory-installed wood nailer continuous around hatch perimeter.

   c. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.

   d. Fabricate curbs to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.
   e. Sloping Roofs: Where slope of roof deck exceeds **1/4 inch per 12 inches (1:48)**, fabricate curb with perimeter curb height that is [**constant**][**tapered to accommodate roof slope so that top surfaces of perimeter curb are level**] . Equip unit with water diverter or cricket on side that obstructs water flow.

9. Dome Glazing: [**Single**][**Double**][**acrylic**][**polycarbonate**] glazing of thickness capable of resisting indicated loads.

   a. Single-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].

b. Outer Double-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].
c. Inner Double-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].

10. Fall Protection Safety Structure: Manufacturer's standard meeting impact load requirements of 29 CFR 1910.23 and authorities having jurisdiction, [**equipped with hail protection galvanized steel wire mesh screen,**] and manually openable from exterior without special tools.
11. Hardware: Manufacturer's standard, corrosion resistant; with hinges, hold-open devices, and independent manual-release devices for [**inside**][**and**][**outside**] operation of lids.

2.6 GRAVITY VENTILATORS

A. Low-Profile, Cylindrical-Style Gravity Ventilator : Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Active Ventilation Products, Inc.**]
b. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
c. [**Dur-Red Products**]
d. [**Greenheck Fan Corporation**]
e. [**Loren Cook Company**]
f. [**Metallic Products Corporation**]
g. [**Moffitt Corporation**]
h. [**PennBarry; division of Air System Components**]
i. [**Romlair Ventilator Co.**]
j. [**Thaler Metal Industries Ltd.**]
k. [**Vent Products Co., Inc**]

2. Construction: Integral base flange, vent cylinder, cylinder bird screen, and [**rain cap**][**hood**] .
3. Dimensions: [**As indicated on Drawings**] .

4. Configuration: [**As indicated on Drawings**].

5. Bird Screens: Manufacturer's standard mesh with rewireable frame.
6. Insect Screens: Manufacturer's standard mesh with rewireable frame.

7. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .
8. Vent Cylinder, Base Flange, Rain-Cap, and Hood Material: [**Zinc-coated (galvanized) steel**][**Aluminum-zinc alloy-coated**][**Aluminum**][**Stainless steel**] sheet, of manufacturer's standard thickness.
9. Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

B. Louvered Penthouse-Style Gravity Ventilator : Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Dur-Red Products**]
b. [**FlashCo Manufacturing Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Loren Cook Company**]
e. [**PennBarry; division of Air System Components**]
f. [**Romlair Ventilator Co.**]
g. [**Vent Products Co., Inc**]

2. Construction: Integral frame with base flange, weathertight cap [**with clear acrylic dome**][**with white translucent acrylic dome**] , and weatherproof sidewall louvers.
3. Dimensions: [**As indicated on Drawings**].

4. Configuration: [**As indicated on Drawings**].

5. Bird Screens: Manufacturer's standard mesh with rewireable frame.
6. Insect Screens: Manufacturer's standard mesh with rewireable frame.

7. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .
8. Frame, Base Flange, Cap, and Louver Material: [**Zinc-coated (galvanized) steel**][**Aluminum-zinc alloy-coated**][**Aluminum**][**Stainless steel**] sheet, of manufacturer's standard thickness.
9. Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

C. Turbine-Style Gravity Ventilator : Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
b. [**Metallic Products Corporation**]
c. [**Moffitt Corporation**]
d. [**PennBarry; division of Air System Components**]
e. [**Romlair Ventilator Co.**]

2. Provide integral weathertight base cap, outlet duct, and rotating louvered turbine.
3. Throat Size and Height: [**As indicated on Drawings**].

4. Configuration: [**As indicated on Drawings**].

5. Bird Screens: Manufacturer's standard mesh with rewireable frame.
6. Insect Screens: Manufacturer's standard mesh with rewireable frame.

7. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .

8. Weathertight Base Cap, Outlet Duct, and Turbine Material: [**Manufacturer's standard**][**Zinc-coated (galvanized) steel**][**Aluminum-zinc alloy-coated**][**Aluminum**] sheet, of manufacturer's standard thickness.

9. Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.7 PIPE AND DUCT SUPPORTS

A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

1. Maximum Diameter Pipe or Conduit: [**1-1/2 inches (38 mm)**].

B. Fixed-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand with roller carrying assembly accommodating pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

1. Roller Carrying Assembly Material: [**Polycarbonate**][**Stainless steel**] .
2. Maximum Diameter Pipe or Conduit: [**7 inches (178 mm)**].

C. Adjustable-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand base, pipe support, and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

1. Maximum Diameter Pipe or Conduit: [**18 inches (457 mm)**].

D. Adjustable-Height Structure-Mounted Pipe Supports: Extruded-aluminum tube, filled with urethane insulation; accommodating pipe or conduit, with provision for pipe retainer; with aluminum baseplate, EPDM base seal, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, stainless steel roller and retainer, and extruded-aluminum carrier assemblies; as required for quantity of pipe runs and sizes.

1. Aluminum Tube Diameter: [**2 inches (50 mm)**].
2. Maximum Diameter Pipe or Conduit: [**7 inches (178 mm)**].

E. Curb-Mounted Pipe Supports: Galvanized-steel support with adjustable-height roller-bearing pipe support accommodating pipe or conduit and with provision for pipe retainer; as required for quantity of pipe runs and sizes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MIRO Industries Inc.**]
   b. [**Pate Company (The)**]
   c. [**PHP Systems/Design**]
   d. [**Portals Plus; Duravent Group**]
   e. [**Roof Products and Systems (RPS); Duravent Group**]
   f. [**Thaler Metal Industries Ltd.**]

2. Corner Joints: Welded [**or mechanically fastened and sealed**] .
3. Curb Sides: [**Straight**][**Integral metal cant**][**Stepped integral metal cant to raise the thickness**

of roof insulation] and integrally formed structure-mounting flange at bottom.

4. Maximum Diameter Pipe or Conduit: [**20 inches (508 mm)**].

F. Duct Supports: Extruded-aluminum, urethane-insulated supports, with manufacturer's recommended hardware for mounting to structure or structural roof deck.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Roof Products and Systems (RPS); Duravent Group**]
   b. [**Thaler Metal Industries Ltd.**]

2. Aluminum Tube Diameter: [**2 inches (50 mm)**].
3. Finish: [**Manufacturer's standard**].

2.8 PIPE PORTALS

A. Curb-Mounted Pipe Portal: Insulated roof-curb units with weathertight curb cover with single or multiple collared openings and pressure-sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless steel snaplock swivel clamps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Portals Plus; Duravent Group**]
   b. [**Roof Products and Systems (RPS); Duravent Group**]

2. Corner Joints: Welded [**or mechanically fastened and sealed**] .
3. Curb Sides: [**Straight**][**Integral metal cant**][**Stepped integral metal cant to raise the thickness of roof insulation**] and integrally formed structure-mounting flange at bottom.

B. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Portals Plus; Duravent Group**]

2.9 PREFORMED FLASHING SLEEVES

A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, with removable metal hood and metal collar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Custom Solution Roof and Metal Products, a division of Colony Heating**]
    b. [**Menzies Metal Products**]
    c. [**Thaler Metal Industries Ltd.**]

2. Height: [**12 inches (300 mm)**].
3. Metal Collar: [**Slotted**][**Perforated**] .

4. Metal: Aluminum sheet, [**0.063 inch (1.60 mm)**] thick.
5. Diameter: [**As indicated on Drawings**][**3 inches (76 mm)**][**4 inches (100 mm)**][**5 inches (125 mm)**][**6 inches (150 mm)**][**7 inches (178 mm)**][**8 inches (200 mm)**][**9 inches (225 mm)**][**10 inches (250 mm)**].
6. Finish: [**Manufacturer's standard**] .

B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Custom Solution Roof and Metal Products, a division of Colony Heating**]
    b. [**Menzies Metal Products**]
    c. [**Milcor by Duravent; Duravent Group.**]
    d. [**Thaler Metal Industries Ltd.**]

2. Metal: [**Aluminum sheet, 0.063 inch (1.60 mm) thick**].
3. Height: [**7 inches (178 mm)**][**13 inches (330 mm)**][**19 inches (480 mm)**].
4. Diameter: [**As indicated on Drawings**][**2 inches (50 mm)**][**3 inches (76 mm)**][**4 inches (100 mm)**][**5 inches (125 mm)**][**6 inches (150 mm)**].
5. Finish: [**Manufacturer's standard**].

2.10 ROOF WALKWAYS

A. Roof Walkway: Metal planking formed from multiple C-shaped channels with upper surface punched in serrated diamond or rectangular shapes to produce raised slip-resistant surface and drainage holes. Provide support framing, brackets, connectors, nosings, and other accessories and components needed for complete installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Atkore Unistrut**]
    b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    c. [**Kee Safety, Inc.**]
    d. [**MIRO Industries Inc.**]
    e. [**PHP Systems/Design**]

2. Compliance Requirements:

   a. Include step units or stairs of similar construction for changes in elevation. Comply with ASCE/SEI 7, 29 CFR 1910.23, and requirements of authorities having jurisdiction.
   b. Equip walkways with safety railings where required to comply with local building codes and requirements of authorities having jurisdiction.

3. Plank Width: [**4-3/4 inches (121 mm)**][**7 inches (178 mm)**][**9-1/2 inches (241 mm)**][**11-3/4 inches (298 mm)**][**18-3/4 inches (476 mm)**][**24 inches (610 mm)**][**As indicated**] .
4. Walkway Width: [**As indicated**].
5. Channel Depth: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**As indicated**] .
6. Metal Material: [**0.079-inch- (2.01-mm-) thick zinc-coated (galvanized) steel sheet**][**0.108-inch- (2.74-mm-) thick zinc-coated (galvanized) steel sheet**][**0.0625-inch- (1.587-mm-) thick stainless steel sheet**][**0.0781-inch- (1.983-mm-) thick stainless steel sheet**][**0.080-inch- (2.03-mm-) thick aluminum sheet**][**0.100-inch- (2.54-mm-) thick aluminum sheet**], perforated, with serrated slip-resistant walking surface.

7. Support Stands: Manufacturer's standard, with protective pads compatible with roofing material.

8. Support Pads: Continuous wood isolation pads, pressure-preservative treated as specified in Section 061000 "Rough Carpentry"; attach roof-walkway supports to pads so that supports are separated from roof membrane surface and walkway support loads are distributed evenly.

9. Wind Restraint: Provide wind-restraint attachment to roof structure of size and spacing required to comply with wind-uplift requirements.
10. Finish: [**Manufacturer's standard**].

2.11 METAL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheer complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality.

1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil (0.005 mm)**.
3. Powder Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

B. Aluminum Sheet: ASTM B209/B209M, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: As manufactured.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil (0.005 mm)**.

3. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
4. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

5. Powder Coat Finish: AAMA 2603. After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Extrusions and Tubes: **ASTM B221 (ASTM B221M)**, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

D. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

E. Steel Shapes: ASTM A36/A36M, hot-dip galvanized in accordance with ASTM A123/A123M unless otherwise indicated.

F. Steel Tube: ASTM A500/A500M, round tube.

G. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized in accordance with ASTM A123/A123M.

H. Steel Pipe: ASTM A53/A53M, galvanized.

2.12 UNDERLAYMENT

A. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over **220 deg F (111 deg C)**; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ATAS International, Inc.**]
   b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   c. [**GCP Applied Technologies Inc.**]
   d. [**Kirsch Building Products**]
   e. [**Owens Corning**]
   f. [**Palisade; Brand of Intertape Polymer Group (IPG)**]
   g. [**PrimeSource Building Products, Inc.**]

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils (0.76 mm)** thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**ATAS International, Inc.**]
b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
c. [**GCP Applied Technologies Inc.**]
d. [**Henry; a Carlisle Company**]
e. [**Palisade; Brand of Intertape Polymer Group (IPG)**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Protecto Wrap Company**]

2. Thermal Stability: Stable after testing at **240 deg F (116 deg C)**; ASTM D1970/D1970M.
3. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)** or lower; ASTM D1970/D1970M.

C. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

D. Slip Sheet: Rosin-sized building paper, **3 lb/100 sq. ft. (0.16 kg/sq. m)** minimum.

2.13 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Acrylic Glazing: ASTM D4802, thermoformable, monolithic sheet, manufacturer's standard, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).

C. Polycarbonate Glazing: Thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar-resistance rated in accordance with UL 972 with an average impact strength of [**12 to 16 ft. lbf/in. (640 to 854 J/m)**] of width when tested in accordance with ASTM D256, Method A (Izod).

D. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.

E. Glass-Fiber Board Insulation: ASTM C726, nominal density of **3 lb/cu. ft. (48 kg/cu. m)**, thermal resistivity of **4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C)**, thickness as indicated.

F. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

G. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, [**containing no arsenic or chromium,**] and complying with AWPA C2; not less than **1-1/2 inches (38 mm)** thick.

H. Security Grilles: [**3/4-inch (19-mm)**] diameter, ASTM A1011/A1011M steel bars spaced [**6 inches (150 mm)**] o.c. in one direction and [**12 inches (300 mm)**] o.c. in the other; factory finished as follows:

1. Surface Preparation: Remove mill scale and rust, if any, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
3. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free,

universal primer; selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats under prolonged exposure.

I. Fasteners: Roof accessory manufacturer's recommended fasteners, designed to comply with performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

J. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

K. Elastomeric Sealant: ASTM C920, elastomeric [**polyurethane**][**silicone**] polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

L. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

M. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

N. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.14 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than **4 inches (100 mm)**.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than **2 inches (50 mm)**.

D. Slip Sheet: Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than **4 inches (100 mm)**.

3.3 INSTALLATION, GENERAL

A. Install roof accessories in accordance with manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended in writing by manufacturer's written installation instructions.

1. Coat concealed side of [**uncoated aluminum**][**and**][**stainless steel**] roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Seal joints with [**elastomeric**][**butyl**] sealant as required by roof accessory manufacturer.

3.4 INSTALLATION OF ROOF ACCESSORIES

A. Roof Curbs: Install each roof curb so top surface is level.

B. Equipment Supports: Install equipment supports so top surfaces are level with each other.

C. Roof Hatches:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post in accordance with manufacturer's written instructions.

D. Heat and Smoke Vents:

1. Install heat and smoke vents so top perimeter surfaces are level.
2. Install and test heat and smoke vents and their components for proper operation in accordance with NFPA 204.

E. Gravity Ventilators: Verify that gravity ventilators operate properly and have unrestricted airflow. Clean, lubricate, and adjust operating mechanisms.

F. Pipe and Duct Supports: Comply with MSS SP-58. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.

1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.

G. Flashing Pipe Portal: Secure pipe portal to roof membrane in accordance with pipe portal manufacturer's written instructions; flash pipe portal flange to surrounding roof membrane in accordance with roof membrane manufacturer's instructions.

H. Preformed Flashing Sleeves: Secure flashing sleeve to roof membrane in accordance with flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane in accordance with roof membrane manufacturer's instructions.

I. Security Grilles: Weld bar intersections and [**using tamper-resistant bolts, attach the**] ends of bars to structural frame or primary curb walls.

3.5 INSTALLATION OF ROOF WALKWAYS

A. Verify that locations of access and servicing points for roof-mounted equipment are served by locations of roof walkways.

B. Remove ballast from top surface of low-slope roofing at locations of contact with roof-walkway supports.

C. Install roof-walkway support pads prior to placement of roof-walkway support stands onto low-slope roofing.

D. Redistribute removed ballast after installation of support pads.

3.6 CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards."**]

C. On completion of installation, clean exposed surfaces in accordance with manufacturer's written instructions. Clean off excess sealants.

3.7 PROTECTION

A. Remove temporary protective coverings and strippable films as roof accessories are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof accessories in a clean condition during construction.

B. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as determined by the Owner.

END OF SECTION 07 72 00 00

SECTION 07 72 13 00 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Louvered-penthouse ventilators.
2. Hooded ventilators.
3. Goosenecks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For gravity ventilators.

1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

D. Samples: For each exposed product and for each color and texture specified.

E. Samples for Initial Selection: For units with factory-applied color finishes.

F. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.

G. Delegated Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of shop-fabricated ventilators.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-framing plans and other details, drawn to scale, and coordinated with each other, based on input from installers of the items involved:

B. Seismic Qualification Data: Certificates for ventilators, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and

describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.5 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ventilators.

B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads, Indicated on Drawings: Determine loads based on pressures as indicated on Drawings.
2. Wind Loads, Basis: Determine loads based on a uniform pressure of [**20 (960)**][**30 (1440)**]<**Insert design wind pressure**> **lbf/sq. ft. (Pa)**, acting inward or outward.
3. Wind Loads, Indicated Below: Determine loads based on pressures indicated below:

    a. Corner Zone: Within <**Insert distance**> of building corners, uniform pressure of <**Insert design wind pressure**>, acting inward, and <**Insert design wind pressure**>, acting outward.
    b. Other Than Corner Zone: Uniform pressure of <**Insert design wind pressure**>, acting inward, and <**Insert design wind pressure**>, acting outward.

4. See [**Section 230548 "Vibration and Seismic Controls for HVAC"**][**Section 230548.13 "Vibration Controls for HVAC"**] for wind-load requirements.
5. Snow Load: Unit to withstand a minimum of [**20- (960-)**]<**Insert design snow load pressure**> **lbf/sq. ft. (Pa)**snow load.

C. Seismic Performance: Ventilators, including attachments to other construction, shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature Change (Range):

a. Ambient: [**120 (67)**]<**Insert temperature**> **deg F (deg C)**.
b. Material Surfaces: [**180 (100)**]<**Insert temperature**> **deg F (deg C)**.

G. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

H. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert number**>.
2. Type: [**Louvered penthouse**][**Hooded penthouse**][**Gooseneck**].
3. Height: <**Insert number**> **inches (mm)**.
4. Width: <**Insert number**> **inches (mm)**.
5. Depth: <**Insert number**> **inches (mm)**.
6. Air Flow: <**Insert number**> **cfm (L/s)**.
7. Maximum Air Pressure Drop: Not more than [**0.10- (25-)**]<**Insert pressure**> **inch wg (Pa)** static pressure drop.
8. Maximum Free Area Velocity: [**600 (3.0)**][**700 (3.6)**][**800 (4.1)**]<**Insert velocity**> **fpm (m/s)**.
9. Function: [**Intake**][**Relief**].

2.2 FABRICATION

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.3 LOUVERED-PENTHOUSE VENTILATORS

A. Description: Multitier rectangular louvered penthouse for [**intake**][**relief**] air.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aire Technologies, Inc.; DMI Companies**]
3. [**Arrow United Industries; Mestek, Inc.**]
4. [**Carnes Company**]
5. [**Greenheck Fan Corporation**]
6. [**JencoFan**]
7. [**Loren Cook Company**]
8. [**PennBarry; division of Air System Components**]
9. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
10. [**Safe Air - Dowco**]
11. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aire Technologies, Inc.; DMI Companies**]
3. [**Arrow United Industries; Mestek, Inc.**]
4. [**Carnes Company**]
5. [**Greenheck Fan Corporation**]
6. [**JencoFan**]
7. [**Loren Cook Company**]
8. [**PennBarry; division of Air System Components**]
9. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
10. [**Safe Air - Dowco**]
11. <**Insert manufacturer's name**>

D. Source Limitations: Obtain louvered-penthouse ventilators from single manufacturer.

E. Construction:

1. Material: All-welded assembly with [**4-inch (100-mm)**][**6-inch (150-mm)**]-deep louvers, mitered corners, and [**aluminum**][**galvanized-steel**] sheet roof.
2. Frame and Blade Material, Extruded Aluminum: Thickness required to comply with structural performance requirements, but not less than [**0.080 (2.0)**]<**Insert value**> **inch (mm)** for frames and [**0.080 (2.0)**][**0.060 (1.5)**]<**Insert value**> **inch (mm)**for blades[**with condensate deflectors**].
3. Frame and Blade Material, Galvanized-Steel Sheet: Thickness required to comply with structural performance requirements, but not less than [**0.052 (1.3)**]<**Insert value**> **inch (mm)** for frames and [**0.040 (1.0)**][**0.052 (1.3)**][**0.064 (1.6)**]<**Insert value**> **inch (mm)** for blades[**with condensate deflectors**].
4. Insulation: [**None**][**Mineral-fiber insulation and vapor barrier**].
5. Wind-Driven Rain Performance: Not less than [**99**][**95**][**80**]<**Insert number**> percent effectiveness when subjected to a rainfall rate of [**3 inches (75 mm) per hour and a wind speed of 29 (13 m/s)**]<**Insert value**> **mph (m/s)** at a free-area intake velocity of [**300 (1.5)**][**400 (2.0)**][**500 (2.5)**]<**Insert velocity**> **fpm (m/s)**.
6. Exterior Corners: Prefabricated corner units with [**mitered and welded blades**][**mitered blades with concealed close-fitting splices**] and with [**fully recessed**][**semirecessed**] mullions at

corners.

7. Bird Screening: [**Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh wire**][**Aluminum, 1/2-inch- (12.7-mm-) square mesh or flattened, expanded aluminum, 3/4-inch- (19-mm-) diamond mesh wire**]<**Insert type**>.
8. Insect Screening: [**Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh wire**]<**Insert type**>.
9. Galvanized-Steel Sheet Finish:

    a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
    b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
    c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and an overall minimum dry film thickness of **2 mils (0.05 mm)**.

        1) Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Dampers:

1. Location: [**Penthouse neck**][**Inside louver face**][**Curb damper tray**].
2. Control: [**Manual**][**Motorized**][**Gravity backdraft**].
3. Tray: Provide damper tray or shelf with opening [**3 (76)**]<**Insert dimension**> **inches (mm)** [**less than interior curb dimensions indicated**][**of size indicated**].

G. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: [**Self-flashing without a cant strip, with**][**Built-in cant and**][**Built-in raised cant and**] mounting flange.
2. Overall Height: [**12 inches (300 mm)**][**36 inches (915 mm)**].

2.4 HOODED VENTILATORS

A. Description: Hooded [**rectangular**][**round**] penthouse for [**intake**][**relief**] air.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Carnes Company**]
3. [**Greenheck Fan Corporation**]
4. [**JencoFan**]
5. [**Loren Cook Company**]
6. [**PennBarry; division of Air System Components**]
7. [**Safe Air - Dowco**]
8. [**Twin City Fan & Blower**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Carnes Company**]
3. [**Greenheck Fan Corporation**]
4. [**JencoFan**]
5. [**Loren Cook Company**]
6. [**PennBarry; division of Air System Components**]
7. [**Safe Air - Dowco**]
8. [**Twin City Fan & Blower**]
9. <**Insert manufacturer's name**>

D. Source Limitations: Obtain hooded ventilators from single manufacturer.

E. Construction:

1. Material, Galvanized Steel: Thickness required to comply with structural performance requirements, but not less than **0.064-inch- (1.62 mm-)** thick base and **0.040-inch- (1.0-mm-)** thick hood; suitably reinforced.
2. Material, Aluminum: Thickness required to comply with structural performance requirements, but not less than **0.063-inch- (1.6-mm-)** thick base and **0.050-inch- (1.27-mm-)** thick hood; suitably reinforced.
3. Insulation: [**None**][**Mineral-fiber insulation and vapor barrier**].
4. Bird Screening: [**Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh wire**][**Aluminum, 1/2-inch- (12.7-mm-) square mesh or flattened, expanded aluminum, 3/4-inch (19-mm) diamond mesh wire**]<**Insert type**>.
5. Insect Screening: [**Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh wire**]<**Insert type**>.

F. Galvanized-Steel Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and an overall minimum dry film thickness of **2 mils (0.05 mm)**.

    a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Dampers:

1. Location: [**Hood neck**][**Curb damper tray**].
2. Control: [**Manual**][**Motorized**][**Gravity backdraft**].
3. Tray: Provide damper tray or shelf with opening [**3 (76)**]<**Insert dimension**> **inches (mm)** [**less than interior curb dimensions indicated**][**of size indicated**].

H. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: [**Self-flashing without a cant strip, with**][**Built-in cant and**][**Built-in raised cant and**] mounting flange.

2. Overall Height: [12 inches (300 mm)][36 inches (900 mm)].

2.5 GOOSENECKS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-5; with a minimum of 0.052-inch- (1.3-mm-) thick, galvanized-steel sheet.

B. Bird Screening: [**Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire**][**Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire**][**Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick**]<**Insert type**>.

C. Insect Screening: [**Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm)**]<**Insert type**>.

D. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: [**Self-flashing without a cant strip, with**][**Built-in cant and**][**Built-in raised cant and**] mounting flange.
2. Overall Height: [12 inches (300 mm)][36 inches (900 mm)].

2.6 SOURCE QUALITY CONTROL

A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

2.7 MATERIALS

A. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B209 (ASTM B209M), Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 (Z275) zinc coating, mill phosphatized.

D. Stainless Steel Sheet: ASTM A666, Type 304, with No. [**4**][**6**] finish.

E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise

indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use [**Phillips flat**][**hex-head or Phillips pan**]-head screws for exposed fasteners unless otherwise indicated.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with zinc-plated hardware [**, that comply with the wind and seismic fastening requirements**]. Use concealed anchorages where possible. Refer to Section 077200 "Roof Accessories."

C. Install goosenecks on curb base where throat size exceeds [**9 by 9 inches (230 by 230 mm)**]<**Insert measurement**>.

D. Install gravity ventilators with clearances for service and maintenance.

E. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.

G. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

H. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

I. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

J. Refer to Section 077200 "Roof Accessories" for flashing and counterflashing of roof curbs.

3.2 DUCT CONNECTIONS

A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 07 72 13 00

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Task	Specification	Specification Description
07 72 13 00	07 72 00 00	Roof Accessories
07 72 23 00	07 72 00 00	Roof Accessories

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SECTION 07 72 26 00 - ASPHALT SHINGLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber-reinforced asphalt shingles.
2. Underlayment materials.
3. Ridge vents.
4. Sheet metal flashing and trim.

B. Related Requirements:

1. Section 077200 "Roof Accessories" for roof ventilators.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified under this Section.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D1079 for definitions of terms related to roofing Work in this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Asphalt shingles.
2. Underlayment materials.
3. Ridge vents.
4. Sheet metal flashing and trim.
5. Asphalt roofing cement.
6. Elastomeric flashing sealant.

B. Shop Drawings: For sheet metal flashing and trim.

C. Samples: For each exposed product and for each color and blend specified, in sizes indicated.

1. Asphalt Shingles: Full size.
2. Ridge and Hip Cap Shingles: Full size.
3. Ridge Vent: **12-inch- (305-mm-)** long Sample.

4. Exposed Valley Lining: **12 inches (305 mm)** square.

D. Samples for Initial Selection:

1. For each type of asphalt shingle indicated.
2. For each type of accessory involving color selection.

E. Samples for Verification: For the following products, in sizes indicated:

1. Asphalt Shingles: Full size.
2. Ridge and Hip Cap Shingles: Full size.
3. Ridge Vent: **12-inch- (305-mm-)** long Sample.
4. Exposed Valley Lining: **12 inches (305 mm)** square.

F. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For roofing system Installer.

B. Product Test Reports: For each type of asphalt shingle and underlayment product indicated, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

C. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For asphalt shingles to include in maintenance manuals.

B. Materials warranties.

C. Roofing system Installer's warranty.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Asphalt Shingles: [**100 sq. ft. (9.3 sq. m)**] of each type and in each color and blend, in unbroken bundles.

1.9 QUALITY ASSURANCE

A. Roofing System Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified asphalt shingle system**

installers][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified asphalt shingle system installers**].

1.10 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of asphalt shingles, including related roofing materials.

a. Size: [**48 inches (1219 mm) long by 96 inches (2438 mm) wide**].
b. Include gutter and downspout complying with requirements in [**Section 076200 "Sheet Metal Flashing and Trim."**][**Section 077100 "Roof Specialties."**]

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store roofing materials in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.

B. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double-stack rolls.

C. Protect unused roofing materials from weather, sunlight, and moisture when left overnight or when roofing Work is not in progress.

D. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.12 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related Work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.13 WARRANTY

A. Materials Warranty: Manufacturer agrees to repair or replace asphalt shingles that fail within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Manufacturing defects.

2. Materials Warranty Period: [**25**][**30**][**35**][**40**][**50**] years from date of Substantial Completion,

prorated, with first [**three**][**five**][**seven**][**10**][**15**][**20**] years nonprorated.

3. Wind-Speed Warranty Period: Asphalt shingles will resist blow-off or damage caused by wind speeds of up to [**60 mph (27 m/s)**][**70 mph (31 m/s)**][**80 mph (36 m/s)**][**100 mph (45 m/s)**][**110 mph (49 m/s)**][**130 mph (58 m/s)**][**135 mph (60 m/s)**] for [**five**][**15**] years from date of Substantial Completion.
4. Algae-Resistance Warranty Period: Asphalt shingles will not discolor for [**five**][**10**][**15**][**20**][**25**] years from date of Substantial Completion.
5. Workmanship Warranty Period: [**Two**][**20**][**25**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of asphalt shingle roofing that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of product from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: Provide asphalt shingles and related roofing materials identical to those of assemblies tested for Class A fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

B. Wind Resistance: Provide asphalt shingles that comply with requirements of ASTM D3161/D3161M, Class F, and with ASTM D7158/D7158M, Class H.

C. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

D. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

E. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

2.3 GLASS-FIBER-REINFORCED ASPHALT SHINGLES

A. Laminated-Strip Asphalt Shingles: ASTM D3462/D3462M, laminated, multi-ply overlay construction; glass-fiber reinforced, mineral-granule surfaced, and self-sealing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Building Products of Canada Corp.**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Malarkey Roofing Products**]
g. [**Owens Corning**]
h. [**PABCO Roofing Products**]
i. [**Tamko Building Products LLC**]

2. Butt Edge: [**Straight**][**Notched**][**Crenelated**] cut.
3. Strip Size: [**Manufacturer's standard**].
4. Algae Resistance: Granules resist algae discoloration.
5. Color and Blends: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Impact-Resistant, Laminated-Strip Asphalt Shingles: ASTM D3462/D3462M, laminated, multi-ply overlay construction; glass-fiber reinforced, mineral-granule surfaced, and self-sealing; with impact resistance complying with UL 2218, Class 4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Building Products of Canada Corp.**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**GAF**]
e. [**Malarkey Roofing Products**]

2. Butt Edge: [**Straight**][**Notched**][**Crenelated**] cut.
3. Strip Size: [**Manufacturer's standard**].
4. Algae Resistance: Granules resist algae discoloration.
5. Color and Blends: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Three-Tab-Strip Asphalt Shingles: ASTM D3462/D3462M; glass-fiber reinforced, mineral-granule surfaced, and self-sealing; with tabs regularly spaced.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Building Products of Canada Corp.**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Malarkey Roofing Products**]
g. [**Owens Corning**]
h. [**PABCO Roofing Products**]
i. [**Tamko Building Products LLC**]

2. Strip Size: [**Manufacturer's standard**].
3. Algae Resistance: Granules resist algae discoloration.
4. Color and Blends: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Impact-Resistant, Three-Tab-Strip Asphalt Shingles: ASTM D3462/D3462M; glass-fiber reinforced, mineral-granule surfaced, and self-sealing; with tabs regularly spaced and with impact resistance complying with UL 2218, Class 4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]

2. Strip Size: [**Manufacturer's standard**].
3. Algae Resistance: Granules resist algae discoloration.
4. Color and Blends: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner..

E. Hip and Ridge Shingles: [**Manufacturer's standard units to match asphalt shingles**][**Site-fabricated units cut from asphalt shingle strips. Trim each side of lapped portion of unit to taper approximately 1 inch (25 mm)**].

2.4 UNDERLAYMENT MATERIALS

A. Organic Felt: Asphalt-saturated organic felts, nonperforated and complying with the following:

1. ASTM D226/D226M: [**Type I**][**Type II**].
2. ASTM D4869/D4869M: [**Type I**][**Type II**][**Type III**][**Type IV**].

B. Glass-Reinforced Felt: ASTM D6757/D6757M, asphalt-saturated, glass-reinforced organic felt or inorganic fiber-based felt.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**GAF**]
    d. [**Owens Corning**]

C. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ALCO Products LLC**]
    b. [**Atlas Polyiso Roof and Wall Insulation**]
    c. [**Building Products of Canada Corp.**]
    d. [**CertainTeed; SAINT-GOBAIN**]
    e. [**Drexel Metals Corp.**]
    f. [**G.A.P. Roofing, Inc.**]
    g. [**GAF**]
    h. [**GCP Applied Technologies Inc.**]
    i. [**IKO Industries Inc.**]
    j. [**Malarkey Roofing Products**]
    k. [**Owens Corning**]
    l. [**PrimeSource Building Products, Inc.**]
    m. [**SDP Advanced Polymer Products Inc.**]
    n. [**SystemComponents Corporation**]
    o. [**Tamko Building Products LLC**]

D. Self-Adhering, Polymer-Modified Bitumen Sheet: ASTM D1970/D1970M, glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ALCO Products LLC**]
    b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
    d. [**CertainTeed; SAINT-GOBAIN**]
    e. [**Drexel Metals Corp.**]
    f. [**GAF**]
    g. [**GCP Applied Technologies Inc.**]
    h. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
    i. [**IKO Industries Inc.**]
    j. [**Malarkey Roofing Products**]
    k. [**Owens Corning**]
    l. [**SDP Advanced Polymer Products Inc.**]
    m. [**Tamko Building Products LLC**]

2. Sheet Thickness: Minimum [**55 mils (1.4 mm)**][**50 mils (1.3 mm)**][**40 mils (1.0 mm)**].
3. Top Surface: [**Sand**][**Granule**][**Textured polymer film**][**Polyester**].

E. Granular-Surfaced Valley Lining: [**ASTM D6380/D6380M, Class M, organic**][**ASTM D3909/D3909M, mineral-granular-surfaced, glass**]-felt-based, asphalt roll roofing; **36 inches (914 mm)** wide.

2.5 RIDGE VENTS

A. Rigid Ridge Vent: Manufacturer's standard, rigid-section, high-density, UV-stabilized plastic ridge vent for use under ridge shingles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
b. [**Benjamin Obdyke Incorporated**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Cor-A-Vent, Inc**]
e. [**GAF**]
f. [**Lomanco, Inc**]
g. [**Owens Corning**]
h. [**Tamko Building Products LLC**]
i. [**Tapco International Corporation; Mid-America Components**]

2. Features:

a. Nonwoven geotextile filter strips.
b. External deflector baffles.

B. Flexible Ridge Vent: Manufacturer's standard, compression-resisting, three-dimensional, open-nylon or polyester-mat filter[**bonded to a nonwoven, nonwicking, geotextile fabric cover**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
b. [**Benjamin Obdyke Incorporated**]
c. [**GAF**]
d. [**Owens Corning**]
e. [**Tamko Building Products LLC**]

2.6 SHEET METAL FLASHING AND TRIM

A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Sheet Metal: [**Copper**][**Stainless steel**][**Zinc-tin alloy coated copper**][**Anodized aluminum**][**Aluminum, mill finished**].

B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item unless otherwise specified in this Section or indicated on Drawings.

1. Apron Flashings: Fabricate with lower flange a minimum of [**4 inches (102 mm)**][**5 inches (127**

mm)] over and [4 inches (102 mm)] beyond each side of downslope asphalt shingles and [6 inches (152 mm)] up the vertical surface.

2. Step Flashings: Fabricate with a headlap of 2 inches (51 mm) and a minimum extension of [4 inches (102 mm)][5 inches (127 mm)] over the underlying asphalt shingle and up the vertical surface.
3. Cricket and Backer Flashings: Fabricate with concealed flange extending a minimum of [18 inches (457 mm)][24 inches (610 mm)] beneath upslope asphalt shingles and [6 inches (152 mm)] beyond each side of [**chimney**][**skylight**] and [6 inches (152 mm)] above the roof plane.
4. Counterflashings: Fabricate to cover [4 inches (102 mm)] of base flashing measured vertically; and in lengths required so that no step exceeds [8 inches (203 mm)] and overall length is no more than [10 feet (3 m)].

    a. Provide metal [**reglets**][**receivers**] for installation.

5. Open-Valley Flashings: Fabricate from metal sheet not less than [24 inches (610 mm)] wide in lengths not exceeding [10 feet (3 m)], with [1-inch- (25-mm-)] high, inverted-V profile water diverter at center of valley and equal flange widths of not less than [11 inches (279 mm)].

    a. Hem flange edges for fastening with metal cleats.
    b. Add stiffening ribs in flashings to promote drainage.

6. Drip Edges: Fabricate in lengths not exceeding [10 feet (3 m)] with minimum 2-inch (51-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.
7. Vent-Pipe Flashings: ASTM B749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof, and extending at least 4 inches (102 mm) from pipe onto roof.

2.7 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D4586/D4586M Type II, asbestos free.

B. Elastomeric Flashing Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag, elastomeric polymer sealant; of class and use classifications required to seal joints and remain watertight; recommended in writing by manufacturer for installation of flashing systems.

C. Roofing Nails: ASTM F1667, aluminum, stainless steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch- (3-mm-) diameter, sharp-pointed, with a 3/8- to 7/16-inch- (10- to 11-mm-) diameter flat head and of sufficient length to penetrate 3/4 inch (19 mm) into solid wood decking or extend at least 1/8 inch (3 mm) through sheathing less than 3/4 inch (19 mm) thick.

    1. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

D. Underlayment Nails: Aluminum, stainless steel, or hot-dip galvanized-steel wire nails with low-profile metal or plastic caps, 1-inch- (25-mm-) minimum diameter.

    1. Provide with minimum 0.0134-inch- (0.34-mm-) thick metal cap, 0.010-inch- (0.25-mm-) thick power-driven metal cap, or 0.035-inch- (0.89-mm-) thick plastic cap; and with minimum 0.083-inch- (2.11-mm-) thick ring shank or 0.091-inch- (2.31-mm-) thick smooth shank of length to penetrate at least 3/4 inch (19 mm) into roof sheathing or to penetrate through roof sheathing less than 3/4 inch (19 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through asphalt shingles.
3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

B. Prepare written report, endorsed by roofing system Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT MATERIALS

A. Comply with asphalt shingle and underlayment manufacturers' written installation instructions and with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in this Section or indicated on Drawings.

B. Organic Felt: Install on roof deck parallel with and starting at eaves and fasten with [**underlayment**][**roofing**] nails.

1. Single-Layer Installation:

   a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
   b. Lap ends a minimum of **4 inches (102 mm)**.
   c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

2. Double-Layer Installation:

   a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
   b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
   c. Lap ends a minimum of **4 inches (102 mm)**. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
   d. Apply a continuous layer of asphalt roofing cement over starter course and on felt surface to be concealed by succeeding courses as each felt course is installed. Apply [**over entire roof**][**at locations indicated on Drawings**].

3. Install felt underlayment [**on roof deck not covered**][**over areas protected**] by self-adhering, polymer-modified bitumen sheet unless otherwise specified in this Section or indicated on Drawings.

   a. Lap sides of felt over self-adhering sheet not less than **4 inches (102 mm)** in direction that sheds water.

b. Lap ends of felt not less than **6 inches (152 mm)** over self-adhering sheet.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Terminate felt [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

C. Synthetic Underlayment:

1. Install on roof deck parallel with and starting at the eaves.

   a. Lap sides and ends as recommended in writing by manufacturer, but not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] for side laps and **6 inches (152 mm)** for end laps.
   b. Stagger end laps between succeeding courses at interval recommended in writing by manufacturer, but not less than **72 inches (1829 mm)**.
   c. Fasten with underlayment nails in accordance with manufacturer's written instructions.
   d. Cover underlayment within period recommended in writing by manufacturer.

2. Install in single layer on roofs sloped at 4:12 and greater.
3. Install in double layer on roofs sloped at less than 4:12.
4. Install synthetic underlayment [**on roof deck not covered**][**over areas protected**] by self-adhering, polymer-modified bitumen sheet unless otherwise specified in this Section or indicated on Drawings.

   a. Lap sides of underlayment over self-adhering sheet not less than **4 inches (102 mm)** in direction to shed water.
   b. Lap ends of underlayment not less than **6 inches (152 mm)** over self-adhering sheet.

5. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
6. Terminate synthetic underlayment [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

D. Self-Adhering, Polymer-Modified Bitumen Sheet: Install, wrinkle free, on roof deck.

1. Comply with low-temperature installation restrictions of underlayment manufacturer.
2. Install lapped in direction that sheds water.

   a. Lap sides not less than **4 inches (102 mm)**.
   b. Lap ends not less than **6 inches (152 mm)**, staggered **24 inches (610 mm)** between succeeding courses.
   c. Roll laps with roller.

3. Prime concrete, masonry, and metal surfaces to receive self-adhering sheet.
4. Eaves: Extend from edges of eaves [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
5. Rakes: Extend from edges of rakes [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
6. Valleys: Extend from lowest to highest point [**18 inches (457 mm)**] on each side of centerline.
7. Hips: Extend [**18 inches (457 mm)**] on each side.
8. Ridges: Extend [**36 inches (914 mm)**] on each side[**without obstructing continuous ridge vent slot**].
9. Sidewalls: Extend [**18 inches (457 mm)**] beyond sidewalls and return vertically against sidewalls not less than [**4 inches (102 mm)**].
10. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend [**18 inches (457 mm)**] beyond penetrating elements and return vertically against penetrating elements not less

than [4 inches (102 mm)].

11. Roof-Slope Transitions: Extend [18 inches (457 mm)] on each roof slope.
12. Cover underlayment within seven days.

E. Granular-Surfaced, Concealed Valley Lining: For [**woven**][**closed-cut**] valleys. Comply with recommendations in NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."

1. Lap roof-deck underlayment over valley lining at least 6 inches (152 mm).
2. Install a 36-inch- (914-mm-) wide strip of granular-surfaced valley lining, with granular-surface face up, centered in valley and fastened to roof deck.
3. Lap ends of strips at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement.
4. Fasten to roof deck.

F. Metal-Flashed, Open-Valley Underlayment: Install two layers of minimum 36-inch- (914-mm-) wide underlayment centered in valley.

1. Use same underlayment as installed on field of roof.
2. Stagger end laps between layers at least 72 inches (1829 mm).
3. Lap ends of each layer at least 12 inches (305 mm) in direction that sheds water, and seal with asphalt roofing cement.
4. Fasten each layer to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.
5. Lap roof-deck underlayment over first layer of valley underlayment at least 6 inches (152 mm).

G. Granular-Surfaced, Open-Valley Lining: Before installing valley lining, install 36-inch- (914-mm-) wide felt underlayment centered in valley. Fasten to roof deck with [**underlayment**][**roofing**] nails.

1. Lap roof-deck felt underlayment over valley felt underlayment at least 6 inches (152 mm).
2. Install an 18-inch- (457-mm-) wide strip of valley lining centered in valley, with granular-surface face down.
3. Install a second 36-inch- (914-mm-) wide strip of valley lining centered in valley, with granular-surface face up.
4. Lap ends of each strip at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement.
5. Stagger end laps between succeeding strips at least 72 inches (1829 mm).
6. Fasten each strip to roof deck.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM

A. Install metal flashings and trim to comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Install metal flashings in accordance with recommendations in[**ARMA's "Asphalt Roofing Residential Manual - Design and Application Methods" and**] NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
2. Bed flanges of metal flashings using asphalt roofing cement or elastomeric flashing sealant.

B. Apron Flashings: Extend lower flange over and beyond each side of downslope asphalt shingles and up the vertical surface.

C. Step Flashings: Install with a headlap of 2 inches (51 mm) and extend over underlying shingle and up the vertical face.

1. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying shingle.
2. Fasten to roof deck only.

D. Cricket and Backer Flashings: Install against roof-penetrating elements extending concealed flange beneath upslope asphalt shingles and beyond each side.

E. Counterflashings: Coordinate with installation of base flashing and fit tightly to base flashing. Lap joints a minimum of **4 inches (102 mm)** secured in a waterproof manner.

1. Install in reglets or receivers.

F. Open-Valley Flashings: Install centered in valleys, lapping ends at least [**8 inches (203 mm)**] in direction that sheds water. Fasten upper end of each length to roof deck beneath overlap.

1. Secure hemmed flange edges into metal cleats spaced [**8 inches (203 mm)**][**12 inches (305 mm)**][**24 inches (610 mm)**] apart and fastened to roof deck.
2. Adhere minimum [**9-inch- (229-mm-)**] wide strips of self-adhering, polymer-modified bitumen sheet to metal flanges and to underlying self-adhering sheet, polymer-modified bitumen sheet.

a. Place strips parallel to and over flanges so that they will be just concealed by installed shingles.

3. Provide a closure at the end of the inverted-V profile of the valley metal to minimize water and ice infiltration.

G. Rake Drip Edges: Install over underlayment materials and fasten to roof deck.

H. Eave Drip Edges: Install below underlayment materials and fasten to roof deck.

I. Pipe Flashings: Form flashing around pipe penetrations and asphalt shingles. Fasten and seal to asphalt shingles as recommended by manufacturer.

3.4 INSTALLATION OF GLASS-FIBER-REINFORCED ASPHALT SHINGLES

A. Install asphalt shingles in accordance with manufacturer's written instructions and recommendations in[**ARMA's "Asphalt Roofing Residential Manual - Design and Application Methods" and**] NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."

B. Install starter strip along lowest roof edge, consisting of an asphalt shingle strip [**with tabs removed**][**at least 7 inches (178 mm) wide**] with self-sealing strip face up at roof edge.

1. Extend asphalt shingles [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] over fasciae at eaves and rakes.
2. Install starter strip along rake edge.

C. Install first and remaining courses of laminated asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.

D. Install first and remaining courses of three-tab-strip asphalt shingles stair-stepping diagonally across roof deck with [**4-inch (102-mm)**][**5-inch (127-mm)**][**6-inch (152-mm)**][**half-tab**][**one-third-tab**][**manufacturer's recommended**] offset pattern at succeeding courses, maintaining uniform exposure.

E. Fasten asphalt shingle strips with a minimum of [**four**][**five**][**six**] roofing nails, but not less than the

number indicated in manufacturer's written instructions for roof slope and design wind speed indicated on Drawings and for warranty requirements specified in this Section.

1. Locate fasteners in accordance with manufacturer's written instructions.
2. Where roof slope exceeds 18:12, hand seal self-sealing asphalt shingles to improve the shingles' positive bond by applying asphalt roofing cement spots between course overlaps after nailing the upper course.
3. Where roof slope is less than 4:12, hand seal self-sealing asphalt shingles to improve the shingles' positive bond by applying asphalt roofing cement spots between course overlaps after nailing the upper course.
4. When ambient temperature during installation is below [**50 deg F (10 deg C)**], hand seal self-sealing asphalt shingles by applying asphalt roofing cement spots between course overlaps after nailing the upper course.

F. Woven Valleys: Extend succeeding asphalt shingle courses from both sides of valley [**12 inches (305 mm)**] beyond center of valley, weaving intersecting shingle-strip courses over each other. Use one-piece shingle strips without joints in valley.

1. Do not nail asphalt shingles within **6 inches (152 mm)** of valley center.

G. Closed-Cut Valleys: Extend asphalt shingle strips from one side of valley [**12 inches (305 mm)**] beyond center of valley.

1. Use one-piece shingle strips without joints in valley.
2. Fasten with extra nail in upper end of shingle. Install asphalt shingle courses from other side of valley and cut back to a straight line **2 inches (51 mm)** short of valley centerline.
3. Trim upper concealed corners of cut-back shingle strips.
4. Do not nail asphalt shingles within **6 inches (152 mm)** of valley center.
5. Set trimmed, concealed-corner asphalt shingles in a **3-inch- (76-mm-)** wide bed of asphalt roofing cement.

H. Open Valleys: Cut and fit asphalt shingles at open valleys, trimming upper concealed corners of shingle strips.

1. [**Maintain uniform width of exposed open valley**][**Widen exposed portion of open valley 1/8 inch in 12 inches (1:96)**] from highest to lowest point.
2. Extend shingle a minimum of **4 inches (102 mm)** over valley metal.
3. Set valley edge of asphalt shingles in a **3-inch- (76-mm-)** wide bed of asphalt roofing cement.
4. Do not nail asphalt shingles to metal open-valley flashings.

I. Ridge Vents: Install continuous ridge vents over asphalt shingles in accordance with manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.

J. Hip and Ridge Shingles: Maintain same exposure of cap shingles as roofing-shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds.

1. Fasten with roofing nails of sufficient length to penetrate sheathing.
2. Fasten ridge cap asphalt shingles to cover ridge vent without obstructing airflow.

3.5 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of the Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System, Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to the Work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When the Work has been damaged by any of foregoing causes, Warranty becomes null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to the Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the Work.
4. During Warranty Period, if the Owner allows alteration of the Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty becomes null and void on date of the alterations, but only to the extent the alterations affect the Work covered by this Warranty. If the Owner engages Roofing System Installer to perform the alterations, Warranty does not become null and void unless Roofing System Installer, before starting the alterations, has notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate the Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty becomes null and void on date of the change, but only to the extent the change affects the Work covered by this Warranty.
6. the Owner to promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect the Work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and does not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty does not operate to relieve Roofing System Installer of responsibility for performance of the Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 72 26 00

Task	Specification	Specification Description
07 72 26 00	07 72 00 00	Roof Accessories
07 72 29 00	07 72 00 00	Roof Accessories
07 72 33 00	07 72 00 00	Roof Accessories
07 72 36 00	07 72 00 00	Roof Accessories
07 72 38 00	07 72 00 00	Roof Accessories
07 72 38 13	07 72 00 00	Roof Accessories
07 72 46 00	07 72 00 00	Roof Accessories

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SECTION 07 72 53 00 - SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pad-type, flat-mounted metal snow guards.
2. Pad-type, flat-mounted plastic snow guards.
3. Pad-type, seam-mounted cast-metal snow guards.
4. Pad-type, seam-mounted plastic snow guards.
5. Rail-type, flat-mounted snow guards.
6. Rail-type, seam-mounted snow guards.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1. Pad-type, flat-mounted metal snow guards.
2. Pad-type, flat-mounted plastic snow guards.
3. Pad-type, seam-mounted cast-metal snow guards.
4. Pad-type, seam-mounted plastic snow guards.
5. Rail-type, flat-mounted snow guards.
6. Rail-type, seam-mounted snow guards.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include details of rail-type snow guards.

C. Samples:

1. Pad-Type Snow Guards: Full-size unit with installation hardware.

a. For units with factory-applied finishes, submit [**manufacturer's standard color selections**][**specified color**].

2. Rail-Type Snow Guards: Bracket, **12-inch- (300-mm-)** long rail, and installation hardware.

a. For units with factory-applied finishes, submit [**manufacturer's standard color selections**][**specified color**].

D. Delegated Design Submittals: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the [**jurisdiction**][**state**] in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: [**2**][**3**].

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

C. Structural Performance: Snow guards to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: [**As indicated on Drawings**].

2.2 PAD-TYPE SNOW GUARDS

A. Pad-Type, Flat-Mounted Metal Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alpine SnowGuards**]
    b. [**Berger; division of OmniMax International, Inc.**]
    c. [**IceBlox Inc.**]
    d. [**Rocky Mountain Snow Guards, Inc.**]
    e. [**Sieger Snow Guards Inc.**]
    f. [**TRA Snow and Sun, Inc.**]
    g. [**Zaleski Snow-Guards for Roofs, Inc.**]

2. Material:

    a. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, not less than [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] thick.

        1) Finish: [**Mill**][**Black epoxy coating**][**Powder coat finish complying with AAMA 2603, with a minimum dry film thickness of 1.5 mils (0.04 mm)**][**High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat**].

            a) Color: [**As selected by Architect from manufacturer's full range**][**Match sheet metal roofing**], as directed by the Owner.

    b. Cast Aluminum: ASTM B26/B26M.
    c. Cast Bronze: ASTM B584.
    d. Copper Sheet: ASTM B370, not less than **16 oz./sq. ft. (0.55 mm thick)**.
    e. Metallic-Coated Steel Sheet: ASTM A653/A653M, with **G90 (Z275)** coating, not less than [**0.022 inch (0.56 mm)**] thick.

        1) Finish: [**Powder coat finish complying with AAMA 2603, with a minimum dry film thickness of 1.5 mils (0.04 mm)**][**High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat**].

            a) Color: [**As selected by Architect from manufacturer's full range**][**Match sheet metal roofing**], as directed by the Owner.

    f. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, **Class AZ50 (Class AZM150)**, **Grade 40 (Grade 275)**, not less than [**0.022 inch (0.56 mm)**] thick.

        1) Finish: [**High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat**].

            a) Color: [**As selected by Architect from manufacturer's full range**][**Match sheet metal roofing**], as directed by the Owner.

    g. Steel Sheet: ASTM A606/A606M, not less than [**0.022 inch (0.56 mm)**] thick.
    h. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**], not less than [**0.0156 inch (0.396 mm)**] thick.

1) Finish: ASTM A480/A480M, [**No. 2D**][**No. 2B**][**No. 3**][**No. 4**].

3. Attachment: Manufacturer's tested system, capable of resisting design loads.

B. Pad-Type, Flat-Mounted Plastic Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpine SnowGuards**]
b. [**Berger; division of OmniMax International, Inc.**]
c. [**IceBlox Inc.**]
d. [**Levi's Building Components**]
e. [**Polar Blox, Inc.**]
f. [**Zaleski Snow-Guards for Roofs, Inc.**]

2. Polycarbonate: ASTM D6098.

a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Attachment: Manufacturer's tested system, capable of resisting design loads.

C. Pad-Type, Seam-Mounted Cast-Metal Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpine SnowGuards**]
b. [**Berger; division of OmniMax International, Inc.**]
c. [**Levi's Building Components**]
d. [**Sieger Snow Guards Inc.**]
e. [**TRA Snow and Sun, Inc.**]

2. Material:

a. Cast Aluminum: ASTM B26/B26M; [**mill**][**factory black epoxy**] finish.
b. Cast Bronze: ASTM B584; polished finish.
c. Cast Brass: ASTM B584; polished finish.

3. Attachment: Manufacturer's tested system, capable of resisting design loads.

D. Pad-Type, Seam-Mounted Plastic Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Polar Blox, Inc.**]

2. Material: Clear UV-stabilized polycarbonate.
3. Attachment: Manufacturer's tested system, capable of resisting design loads.

2.3 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Flat-Mounted Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpine SnowGuards**]
   b. [**Berger; division of OmniMax International, Inc.**]
   c. [**IceBlox Inc.**]
   d. [**Rocky Mountain Snow Guards, Inc.**]
   e. [**S-5! Metal Roof Innovations, Ltd.**]
   f. [**Sieger Snow Guards Inc.**]
   g. [**TRA Snow and Sun, Inc.**]

2. Description: Units fabricated from metal baseplate anchored to [**adjustable**][**fixed**] bracket and equipped with [**one**][**two**][**three**][**four**] bar(s), rail(s), or pipe(s).
3. Brackets and Baseplate: [**ASTM B209 (ASTM B209M) aluminum; mill finished**][**ASTM B209 (ASTM B209M) aluminum; clear anodized**][**ASTM B584 bronze or brass**][**ASTM A240/A240M, Type 304 stainless steel; mill finish**][**Galvanized steel, G90 coating**][**Galvanized steel, G60 (Z180) coating**].
4. Bars: [**ASTM B221 (ASTM B221M) aluminum; mill finish**][**ASTM B221 (ASTM B221M) aluminum; clear anodized**][**ASTM B584 bronze or brass**][**ASTM A240/A240M, Type 304 stainless steel; mill finish**].

   a. Profile: [**Round**][**Square**][**with integral track to accept color-matching inserts of material and finish used for metal roof**].

5. Seam Clamps: **ASTM B221 (ASTM B221M)** aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

B. Rail-Type, Seam-Mounted Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpine SnowGuards**]
   b. [**Berger; division of OmniMax International, Inc.**]
   c. [**IceBlox Inc.**]
   d. [**LMCurbs**]
   e. [**PMC Industries, Inc**]
   f. [**Rocky Mountain Snow Guards, Inc.**]
   g. [**S-5! Metal Roof Innovations, Ltd.**]

h. [**TRA Snow and Sun, Inc.**]

2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with [**one rail**][**two rails**][**three rails**][**one rail with integral track to accept color-matching inserts of material and finish used for metal roof**][**two rails with integral track to accept color-matching inserts of material and finish used for metal roof**][**three rails with integral track to accept color-matching inserts of material and finish used for metal roof**].
3. Brackets and Baseplate: [**ASTM B209 (ASTM B209M) aluminum; mill finished**][**ASTM B209 (ASTM B209M) aluminum; clear anodized**][**ASTM A240/A240M, Type 304 stainless steel; mill**][**ASTM A240/A240M, Type 304 stainless steel; 180-grit polished finish, uniform, directionally textured finish**][**ASTM A240/A240M, Type 304 stainless steel; 320-grit polished finish, oil-ground, uniform, fine, directionally textured finish**][**ASTM B584 brass; polished**].
4. Bars: [**ASTM B221 (ASTM B221M) aluminum; mill finish**][**ASTM B221 (ASTM B221M) aluminum, clear anodized**][**ASTM A240/A240M, Type 304 stainless steel; mill finish**][**ASTM A240/A240M, Type 304 stainless steel; 180-grit polished finish, uniform, directionally textured finish**][**ASTM A240/A240M, Type 304 stainless steel; 320-grit polished finish, oil-ground, uniform, fine, directionally textured finish**][**ASTM B584 brass; polished**][**Galvanized steel, G90 (Z275) coating**][**Galvanized steel, G60 (Z180) coating**].

    a. Profile: [**Round**][**Square**][**with integral track to accept color-matching inserts of material and finish used for metal roof**].

5. Seam Clamps: **ASTM B221 (ASTM B221M)** aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as indicated on [**Drawings**][**Shop Drawings**].
2. Space rows as recommended by manufacturer.

B. Attachment for Asphalt Shingle Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Mechanically anchored through each factory-prepared hole with fasteners concealed by the shingles**][**Retrofit mechanical anchor and counterflashing sleeve system**].
2. Rail-Type, Flat-Mounted, Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

C. Attachment for Wood Shingle and Shake Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Mechanically anchored through each factory-prepared hole with fasteners concealed by the shingles**][**Retrofit mechanical anchor and counterflashing sleeve system**][**Hook and mechanically anchored through each factory-prepared hole, concealed by shingles and shakes**].
2. Rail-Type, Flat-Mounted Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

D. Attachment for Slate Shingle Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Mechanically anchored through each factory-prepared hole with fasteners concealed by the shingles**][**Retrofit strap-and-hook system**][**Retrofit mechanical anchor and counterflashing sleeve system**][**Hook and mechanically anchored through each factory-prepared hole, concealed by shingles**].
2. Rail-Type, Flat-Mounted Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

E. Attachment for Metal Shingle Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Mechanically anchored through each factory-prepared hole with fasteners concealed by the shingles**][**Mechanical anchor and counterflashing sleeve system**].
2. Rail Type, Flat-Mounted Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

F. Attachment for Tile Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Hooked to tile and roof batten with head of snow guard positioned over headlap of tile**][**Hook and mechanically anchored through each factory-prepared hole, concealed by roof tiles**].
2. Rail-Type, Flat-Mounted Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

G. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
2. Pad-Type, Flat-Mounted Snow Guards:

    a. [**Mechanically attach**][**Adhere**] to metal roofing in accordance with manufacturer's written instructions.
    b. Solder to copper roofing in accordance with manufacturer's written instructions.

3. Pad-Type, Seam-Mounted Snow Guards:

a. Install snow guards in straight rows.
b. Secure in place using stainless steel set screws, incorporating round nonpenetrating point.
c. Torque set screw in accordance with manufacturer's written instructions.

4. Rail-Type, Seam-Mounted Snow Guards:

a. Install brackets to vertical ribs in straight rows.
b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
c. Torque set screw in accordance with manufacturer's written instructions.
d. Install cross members to brackets.

H. Attachment for Exposed Fastened Metal Roofing:

1. Do not use fasteners that will void metal roofing finish warranty.
2. Pad-Type, Flat-Mounted Snow Guards:

a. Adhere to metal roofing in accordance with manufacturer's written instructions.
b. Mechanically fasten to metal roofing, using fasteners identical to those used to secure metal roofing to substrate.
c. Solder to copper roofing in accordance with manufacturer's written instructions.

3. Rail-Type, Flat-Mounted Snow Guards:

a. Install brackets in straight rows.
b. Mechanically fasten to metal roofing, using sealant and mechanical fasteners identical to those used to secure metal roofing to substrate.
c. Install cross members to brackets.

END OF SECTION 07 72 53 00

Task	Specification	Specification Description
07 72 53 00	07 72 26 00	Asphalt Shingles
07 72 53 00	07 72 00 00	Roof Accessories

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SECTION 07 72 56 00 - HEAT TRACING FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-regulating, parallel-resistance heating cables.

B. Related Requirements:

1. Section 220533 "Heat Tracing for Plumbing Piping."
2. Section 230533 "Heat Tracing for HVAC Piping."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables and controls to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**Three**][**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chromalox, Inc.**]
2. [**RAYCHEM; brand of nVent Electrical plc**]
3. [**Thermon, Inc.**]

B. Source Limitations: Obtain all heat tracing from one manufacturer.

C. Standard: IEEE 515.1.

D. Heating Element: Pair of parallel [**No. 16**][**No. 18**] AWG, [**tinned**][**nickel-coated**], stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.

E. Electrical Insulating Jacket: Flame-retardant polyolefin.

F. Grounding Cover: [**Copper**][**Tinned-copper**] braid.

G. Cable Cover: Polyolefin outer jacket with ultraviolet inhibitor.

H. Terminate cable with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.

I. Maximum Operating Temperature (Power On): [**150 deg F (65 deg C)**].

J. Maximum Exposure Temperature (Power Off): [**185 deg F (85 deg C)**].

K. Electrical Components, Devices, and Accessories: Listed and labeled for fire protection use as defined in NFPA 70 and NFPA 13 by a qualified testing agency, and marked for intended location and application. All heating cable used on branch sprinkler piping is to be listed and labeled by a qualified testing agency specifically for this use.

L. Capacities and Characteristics:

1. Maximum Heat Output: [**3 W/ft. (9.8 W/m)**][**5 W/ft. (16.4 W/m)**][**8 W/ft. (26 W/m)**][**10 W/ft. (32.8 W/m)**][**12 W/ft. (39.4 W/m)**].
2. Electrical Characteristics for Single-Circuit Connection:

a. Volts: [**120**][**208**][**240**][**277**][**480**] V.

2.2 CONTROLS

A. Control Panel:

1. [**Microprocessor-based**][**Automatic**] control with manual on, automatic, and standby/reset switch.

2. Remote temperature sensor senses outside air temperature; programmable to energize the cable when temperature falls below [34 to 44 deg F (1 to 7 deg C)].
3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and temperature sensors.
4. Minimum 30 A contactor to energize cable or close other contactors.
5. Ground-fault protection.
6. Single-point control of heat tracing for freeze protection.
7. Provide communication ports with contacts, RS485, or Ethernet interface for remote monitoring and alarm by fire-alarm system. Coordinate type of connection ports with [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer or as recommended in writing by manufacturer.

B. Warning Labels: See Section 210553 "Identification for Fire-Suppression Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable at locations indicated and install in accordance with NFPA 70 and NFPA 13.

B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 210700 "Fire-Suppression Systems Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install temperature-control units in an accessible location and according to manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

I. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.

J. Install and connect outside air and pipe temperature sensors.

3.3 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect heat-tracing controls to fire-alarm system in accordance with NFPA 13. Comply with requirements in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

D. Connect temperature-control unit to interrupt power supply to electric heating cable when outside air is above set point.

E. Connect remote electronic temperature sensors.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 07 72 56 00

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SECTION 07 72 56 00A - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-regulating, parallel-resistance electric heating cables.
2. Controls.

B. Related Requirements:

1. Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Section 230533 "Heat Tracing for HVAC Piping."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality Control Reports: For specified tests and inspections.

B. Sample Warranties: For specified special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables and controls.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**Three**][**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Self-Regulating, Parallel-Resistance Heating Cables:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**BriskHeat**]
    b. [**Chromalox, Inc.**]
    c. [**Delta-Therm Corporation**]
    d. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
    e. [**Nelson; Emerson Electric Co., Automation Solutions**]
    f. [**Raychem (a brand of Chemelex)**]
    g. [**Thermon, Inc.**]
    h. [**Trasor Corp.**]
    i. [**WarmlyYours Radiant, Inc.**]

2. Source Limitations: Obtain all heat tracing from one manufacturer.
3. Standard: IEEE 515.1.
4. Heating Element: Pair of parallel [**No. 16**][**No. 18**] AWG, [**tinned**][**nickel-coated**] , stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
5. Electrical Insulating Jacket: Flame-retardant polyolefin.
6. Grounding Cover: [**Copper**][**Tinned-copper**] braid.
7. Cable Cover: Polyolefin outer jacket with ultraviolet inhibitor.
8. Terminate cable with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.
9. Maximum Operating Temperature (Power On): [**150 deg F (65 deg C)**].
10. Maximum Exposure Temperature (Power Off): [**185 deg F (85 deg C)**].
11. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a qualified testing agency, and marked for intended location and application.
12. Capacities and Characteristics:

    a. Maximum Heat Output: [**3 W/ft. (9.8 W/m)**][**5 W/ft. (16.4 W/m)**][**8 W/ft. (26 W/m)**][**10 W/ft. (32.8 W/m)**][**12 W/ft. (39.4 W/m)**].
    b. Electrical Characteristics for Single-Circuit Connection:

        1) Volts: [**120**][**208**][**240**][**277**][**480**] V.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote Bulb Temperature Control Unit: Adjustable temperature range from [**30 to 50 deg F**

(minus 1 to plus 10 deg C)].

2. Single-Pole Switch: Snap action; open-on-rise; with minimum current rating adequate for connected cable.
3. Remote Temperature-Sensing Bulb: On capillary, resistance temperature device, or thermistor for directly sensing outside air or pipe-wall temperature.
4. Enclosure: Corrosion resistant, waterproof.

B. Control Panel:

1. Control Type: [**Microprocessor-based**][**Automatic**] control with manual on, automatic, and standby/reset switch.
2. Remote Outside Air Temperature Sensor: Programmable to energize the freeze-protection cable when temperature falls below [**34 to 44 deg F (1 to 7 deg C)**].
3. Remote Domestic Hot Water Temperature Sensor: Programmable to control the domestic hot water temperature at [**110 to 120 deg F (47 to 53 deg C)**].
4. Enclosure: Corrosion proof and waterproof, suitable for outdoor mounting, for controls and temperature sensors.
5. Contactor: Minimum 30 A to energize cable or close other contactors.
6. Ground-fault protection.
7. Single-Point Control of Heat Tracing: For freeze protection [**and domestic hot-water-temperature maintenance**] .
8. Provide communication ports with contacts, RS485, or Ethernet interface for remote monitoring and alarm by central HVAC-control system. Coordinate type of connection ports with Section 230923 "Direct Digital Control (DDC) System for HVAC."

C. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:

1. Microprocessor based.
2. Minimum of four separate schedules.
3. Minimum 24-hour battery carryover.
4. On-off-auto switch.
5. 365-day calendar with 20 programmable holidays.
6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC-control system.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: See Section 220553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least **3 mils (0.08 mm)** thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): **3/4 inch (19 mm)** minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: **1-1/2 inches (38 mm)** minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Install electric heating cable at locations indicated and in accordance with NFPA 70.

B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 220719 "Plumbing Piping Insulation."

F. Set field-adjustable switches and circuit-breaker trip ranges.

G. Warning Tape: Install warning tape on piping insulation where piping is equipped with electric heating cables.

3.3 INSTALLATION OF CONTROLS

A. Install temperature-control units in an accessible location and in accordance with manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

B. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.

C. Install and connect outside air and pipe temperature sensors.

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect temperature-control unit for freeze protection to interrupt power supply to electric heating cable when outside air is above set point.

D. Connect temperature-control unit for domestic hot-water-temperature maintenance to interrupt power supply to electric heating cable when hot water is above set point.

E. Connect remote electronic temperature sensors.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Test and Inspections: Perform the following [**with the assistance of a factory-authorized service representative**] :

1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 07 72 56 00A

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SECTION 07 72 56 00B - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-regulating, parallel-resistance heating cables.
2. Controls.

B. Related Requirements:

1. Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Section 220533 "Heat Tracing for Plumbing Piping."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality Control Reports: For specified tests and inspections.

B. Sample Warranties: For specified special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables and controls.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**Three**][**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Self-Regulating, Parallel-Resistance Heating Cables:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**BriskHeat**]
    b. [**Chromalox, Inc.**]
    c. [**Delta-Therm Corporation**]
    d. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
    e. [**Raychem (a brand of Chemelex)**]
    f. [**Thermon, Inc.**]
    g. [**Trasor Corp.**]
    h. [**WarmlyYours Radiant, Inc.**]

2. Source Limitations: Obtain all heat tracing from single manufacturer.
3. Standard: IEEE 515.1.
4. Heating Element: Pair of parallel [**No. 16**][**No. 18**] AWG, [**tinned**][**nickel-coated**] , stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
5. Electrical Insulating Jacket: Flame-retardant polyolefin.
6. Grounding Cover: [**Copper**][**Tinned-copper**] braid.

7. Cable Cover: [**Tinned-copper**][**Stainless steel**] braid [**and polyolefin outer jacket with ultraviolet inhibitor**] .
8. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.
9. Maximum Operating Temperature (Power On): [**150 deg F (65 deg C)**].

10. Maximum Exposure Temperature (Power Off): [**185 deg F (85 deg C)**].
11. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

12. Capacities and Characteristics:

    a. Maximum Heat Output: [**3 W/ft. (9.8 W/m)**][**5 W/ft. (16.4 W/m)**][**8 W/ft. (26 W/m)**][**10 W/ft. (32.8 W/m)**][**12 W/ft. (39.4 W/m)**] .
    b. Electrical Characteristics for Single-Circuit Connection:

        1) Volts: [**120**][**208**][**240**][**277**][**480**] V.
        2) Phase: [**1**][**3**].
        3) Hertz: [**60**] Hz.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb temperature-control unit with adjustable range from [30 to 50 deg F (minus 1 to plus 10 deg C)].
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote temperature-sensing bulb on capillary, resistance temperature device, or thermistor for directly sensing ambient air or pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

B. Control Panel:

1. [**Microprocessor-based**][**Automatic**] control with manual on, automatic, and standby/reset switch.
2. Remote temperature sensors sense outside air temperature; programmable to energize the cable when temperature falls below [34 to 44 deg F (1 to 7 deg C)].
3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30 A contactor to energize cable or close other contactors.
5. Ground-fault protection.
6. Single-point control of heat tracing for freeze protection.

7. Provide communication ports with contacts, RS485, or Ethernet interface for remote monitoring and alarm by central HVAC-control system. Coordinate type of connection ports with Section 230923 "Direct Digital Control (DDC) System for HVAC."

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: See Section 230553 "Identification for HVAC Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Install electric heating cable at locations indicated and in accordance with NFPA 70.

B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 230719 "HVAC Piping Insulation."

F. Set field-adjustable switches and circuit-breaker trip ranges.

G. Warning Tape: Install warning tape on piping insulation where piping is equipped with electric heating cables.

3.3 INSTALLATION OF CONTROLS

A. Install temperature-control units in an accessible location and in accordance with manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

B. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.

C. Install outside air and pipe temperature sensors.

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect temperature-control unit to interrupt power supply to electric heating cable when outside air is above set point.

D. Connect remote electronic temperature sensors.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Test and Inspections: Perform the following [**with the assistance of a factory-authorized service representative**] :

1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 07 72 56 00B

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SECTION 07 72 56 00C - RADIANT-HEATING ELECTRIC CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes electric heating cables for ceiling or floor radiant heating, snow and ice melting on pavement, and freezer-floor frost-heave prevention with the following electric heating cables:

1. Mineral insulated, series resistance.
2. Plastic insulated, series resistance.
3. Self-regulating, parallel resistance.

B. Related Requirements:

1. Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Section 220533 "Heat Tracing for Plumbing Piping."
3. Section 230533 "Heat Tracing for HVAC Piping."
4. Section 238213 "Valance Heating and Cooling Units" for factory-fabricated electric heating panels for ceiling and wall applications.
5. Section 238323 "Radiant-Heating Electric Panels."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, sections, details, and attachments to other work.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Items installed in finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

g. **<Insert item>**.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**10**][**15**]**<Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR ELECTRIC HEATING CABLES

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 MINERAL-INSULATED, SERIES-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chromalox, Inc.**]
2. [**Delta-Therm Corporation**]
3. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
4. [**Nelson; Emerson Electric Co., Automation Solutions**]
5. [**RAYCHEM; brand of nVent Electrical plc**]
6. [**Trasor Corp.**]
7. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Chromalox, Inc.**]
2. [**Delta-Therm Corporation**]
3. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
4. [**Nelson; Emerson Electric Co., Automation Solutions**]
5. [**RAYCHEM; brand of nVent Electrical plc**]
6. [**Trasor Corp.**]
7. **<Insert manufacturer's name>**

C. Comply with UL 1673.

D. Heating Element: Single- or dual-conductor resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

E. Electrical Insulating Mineral: Magnesium oxide.

F. Cable Cover: Copper-nickel alloy[**and high-density polyethylene outer jacket**].

G. Maximum Operating Temperature: [**300 deg F (150 deg C)**]<**Insert temperature**>.

H. Capacities and Characteristics:

1. Maximum Heat Output: [**6 W/ft. (19.7 W/m)**][**7.5 W/ft. (24.6 W/m)**]<**Insert value**>.
2. Spacing: <**Insert inches (mm)**>.
3. Electrical Characteristics for Single-Circuit Connection:

    a. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
    b. Phase: <**Insert value**>.
    c. Hertz: <**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 PLASTIC-INSULATED, SERIES-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Delta-Therm Corporation**]
2. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
3. [**NUHEAT; brand of nVent Electrical plc**]
4. [**Orbit Manufacturing**]
5. [**RAYCHEM; brand of nVent Electrical plc**]
6. [**SunTouch; A Watts Water Technologies Company**]
7. [**WarmlyYours Radiant, Inc.**]
8. [**Warmup Inc.**]
9. [**Warmzone Premier Radiant Heating**]
10. [**WATTS; A Watts Water Technologies Company**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Delta-Therm Corporation**]
2. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
3. [**NUHEAT; brand of nVent Electrical plc**]
4. [**Orbit Manufacturing**]
5. [**RAYCHEM; brand of nVent Electrical plc**]
6. [**SunTouch; A Watts Water Technologies Company**]
7. [**WarmlyYours Radiant, Inc.**]
8. [**Warmup Inc.**]
9. [**Warmzone Premier Radiant Heating**]
10. [**WATTS; A Watts Water Technologies Company**]

11. <**Insert manufacturer's name**>

C. Comply with UL 1673.

D. Heating Element: Single resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

E. Electrical Insulating Jacket: Minimum **4.0-mil (0.10-mm)** Kapton with silicone or Tefzel.

F. Cable Cover: [**Aluminum**][**Stainless-steel**][**Nickel**] braid[**with silicone or Hylar outer jacket**].

G. Maximum Operating Temperature: [**300 deg F (150 deg C)**]<**Insert temperature**>.

H. Cable-Heated Mats: Factory-fabricated cable and fiberglass or plastic mesh with uniform [**1-1/2-inch (38-mm)**][**3-inch (76-mm)**]<**Insert dimension**> cable spacing, in [**18-inch (457-mm)**][**36-inch (914-mm)**]<**Insert dimension**> widths.

I. Capacities and Characteristics:

1. Maximum Heat Output (Cable): [**6 W/ft. (19.7 W/m)**][**7.5 W/ft. (24.6 W/m)**]<**Insert value**>.
2. Maximum Heat Output (Mat): [**12 W/sq. ft. (129 W/sq. m)**][**16 W/sq. ft. (172 W/sq. m)**]<**Insert value**>.
3. Spacing: <**Insert inches (mm)**>.
4. Electrical Characteristics for Single-Circuit Connection:

    a. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
    b. Phase: <**Insert value**>.
    c. Hertz: <**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.4 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BriskHeat**]
2. [**Chromalox, Inc.**]
3. [**Delta-Therm Corporation**]
4. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
5. [**Nelson; Emerson Electric Co., Automation Solutions**]
6. [**RAYCHEM; brand of nVent Electrical plc**]
7. [**Thermon, Inc.**]
8. [**Trasor Corp.**]
9. [**Warmup Inc.**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BriskHeat**]
2. [**Chromalox, Inc.**]

3. [**Delta-Therm Corporation**]
4. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
5. [**Nelson; Emerson Electric Co., Automation Solutions**]
6. [**RAYCHEM; brand of nVent Electrical plc**]
7. [**Thermon, Inc.**]
8. [**Trasor Corp.**]
9. [**Warmup Inc.**]
10. <**Insert manufacturer's name**>

C. Comply with UL 1673.

D. Heating Element: Pair of parallel [**No. 16**][**No. 18**] AWG, [**tinned**][**nickel-coated**], stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

E. Electrical Insulating Jacket: Flame-retardant polyolefin.

F. Cable Cover: [**Tinned-copper**][**Stainless-steel**] braid[**with polyolefin outer jacket with ultraviolet inhibitor**].

G. Maximum Operating Temperature: [**300 deg F (150 deg C)**]<**Insert temperature**>.

H. Cable-Heated Mats: Factory-fabricated cable and fiberglass or plastic mesh with uniform [**1-1/2-inch (38-mm)**][**3-inch (76-mm)**]<**Insert dimension**> cable spacing, in [**18-inch (457-mm)**][**36-inch (914-mm)**]<**Insert dimension**> widths.

I. Capacities and Characteristics:

1. Maximum Heat Output (Cable): [**3 W/ft. (9.8 W/m)**][**5 W/ft. (16.4 W/m)**][**8 W/ft. (26 W/m)**][**10 W/ft. (32.8 W/m)**][**12 W/ft. (39.4 W/m)**]<**Insert value**>.
2. Maximum Heat Output (Mat): [**6 W/sq. ft. (65 W/sq. m)**][**12 W/sq. ft. (129 W/sq. m)**][**16 W/sq. ft. (172 W/sq. m)**][**24 W/sq. ft. (260 W/sq. m)**]<**Insert value**>.
3. Spacing: <**Insert inches (mm)**>.
4. Electrical Characteristics for Single-Circuit Connection:

    a. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
    b. Phase: <**Insert value**>.
    c. Hertz: <**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.5 CONTROLS

A. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control devices and sequence of operations for radiant-heating electric cables.

B. Wall-Mounted Thermostats for Ceiling and Floor Heating Cables:

1. Minimum temperature range from [**50 to 90 deg F (10 to 32 deg C)**]<**Insert temperature range**>.
2. Manually operated with on-off switch.

C. Precipitation and Temperature Sensor for Snow Melting on Pavement:

1. [**Microprocessor-based**][**Automatic**] control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to energize the cable as follows:

   a. Temperature Span: [**34 to 44 deg F (1 to 7 deg C)**]<**Insert temperature range**>.
   b. Adjustable Delay-Off Span: [**30 to 90**]<**Insert time**> minutes.
   c. Energize Cables: Following [**two**]<**Insert time**>-minute delay if ambient temperature is below set point and precipitation is detected.
   d. De-Energize Cables: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to energize cable or close other contactors.
5. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

2.6 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Embedded Heating-Cable Identification:

1. Flush-mounted cast-iron boxes with identification on lid according to NFPA 70.
2. Mechanically fastened [**metal**][**plastic**] signage with identification according to NFPA 70 and complying with requirements in [**Section 101416 "Plaques."**][**Section 101419 "Dimensional Letter Signage."**][**Section 101423 "Panel Signage."**]
3. Mechanically fastened [**metal**][**plastic**][**concrete**] post-mounted signage with identification according to NFPA 70 and complying with requirements in [**Section 101416 "Plaques."**][**Section 101419 "Dimensional Letter Signage."**][**Section 101423 "Panel Signage."**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables or cable-heated mats for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces in contact with electric heating cables or cable-heated mats are free of burrs and sharp protrusions.
2. Ensure surfaces and substrates are level and plumb.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Ceiling Radiant Heating: [**Plastic-insulated, series-resistance**][**Self-regulating, parallel-resistance**] heating cable.
2. Floor Radiant Heating: [**Plastic-insulated, series-resistance**][**Self-regulating, parallel-resistance**] heating cable.
3. Snow and Ice Melting on Pavement: [**Mineral-insulated, series-resistance**][**Plastic-insulated, series-resistance**][**Self-regulating, parallel-resistance**] heating cable.
4. Freezer-Floor Frost-Heave Prevention: [**Plastic-insulated, series-resistance**][**Self-regulating, parallel-resistance**] heating cable.

3.3 INSTALLATION

A. Install electric heating cable or cable-heated mats across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Do not energize cables embedded in concrete or plaster until those assemblies are cured.

C. Electric Heating-Cable Installation for Ceiling Radiant Heating: Install heating cable or cable-heated mat with heat-conductive fill materials such as plaster to ensure direct contact with finished radiant surfaces.

D. Electric Heating-Cable Installation for Floor Radiant Heating: Install heating cable or cable-heated mat with heat-conductive fill materials such as concrete to ensure direct contact with finished radiant surfaces.

E. Electric Heating-Cable or Cable-Heated-Mat Installation for Snow and Ice Melting in Pavement:

1. Install heating cable or cable-heated mat with heat-conductive fill materials such as asphalt or concrete to ensure direct contact with finished radiant surfaces.
2. Install cables or cable-heated mats after applying bituminous binder course to lower base; ensure that second bituminous binder course is applied to cables or mats before pouring finish topping.
3. Install embedded electric heating-cable or cable-heated-mat identification box where indicated in pavement before pavement work is completed.
4. Stamp concrete with embedded electric heating-cable or cable-heated-mat identification according to NFPA 70 and complying with requirements in Section 033000 "Cast-in-Place Concrete."
5. Mount precipitation sensor in pavement.

F. Electric Heating-Cable Installation for Freezer-Floor Frost-Heave Prevention: Install electric heating cable or cable-heated mat below insulation in subsoil.

1. Install embedded electric heating-cable or cable-heated-mat identification box where indicated.
2. Install embedded electric heating-cable or cable-heated-mat identification according to NFPA 70 on adjacent structure and complying with requirements in [**Section 101416 "Plaques."**][**Section 101419 "Dimensional Letter Signage."**][**Section 101423 "Panel Signage."**]
3. Install embedded electric heating-cable or cable-heated-mat identification according to NFPA 70 on [**metal**][**wood**][**concrete**] post and complying with requirements in [**Section 101416 "Plaques."**][**Section 101419 "Dimensional Letter Signage."**][**Section 101423 "Panel Signage."**]
4. Stamp concrete with embedded electric heating-cable or cable-heated-mat identification according to NFPA 70 and complying with requirements in Section 033000 "Cast-in-Place Concrete."

G. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying finished surface on heating cables.

E. Radiant-heating electric cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged radiant-heating electric cables and cable-heated mats.

END OF SECTION 07 72 56 00C

Task	Specification	Specification Description
07 72 56 00	07 72 00 00	Roof Accessories
07 72 63 00	01 11 19 00	No Specification Required
07 72 63 00	07 72 00 00	Roof Accessories
07 73 00 00	07 65 16 00	Built-Up Asphalt Roofing
07 73 00 00	07 05 13 00	Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 73 00 00	07 05 13 00a	Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 73 00 00	07 05 13 00b	Chlorosulfonate-Polyethylene (CSPE) Roofing
07 73 00 00	07 05 13 00c	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 76 16 00	01 11 19 00	No Specification Required

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SECTION 07 81 00 00 - APPLIED FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Sprayed fire-resistive materials.

B. Related Requirements:

1. Section 078123 "Intumescent Fire Protection" for mastic and intumescent fire-resistive coatings.
2. Section 099646 "Intumescent Painting" for intumescent paints that are fire retarding but not fire resistive.

1.2 DEFINITIONS

A. SFRM: Sprayed fire-resistive materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Framing plans or schedules, or both, indicating the following:

1. Extent of applied fire protection for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3. Minimum applied fire protection material thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of sprayed fire-resistive material after application.

C. Samples: For each exposed product and for each color and texture specified, [**in manufacturer's standard dimensions**][**4 inches (102 mm) square**] in size.

D. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.
3. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
4. Health Product Declaration (HPD): Provide documentation confirming product compliance with

one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of applied fire protection material for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Research Reports: For each type of applied fire protection material, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**].

C. Preconstruction Test Reports: For each type of applied fire protection material.

D. Field Quality-Control Reports: For each type of applied fire protection material.

E. Qualification Statements: For [**Installer**] [**testing agency**].

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by applied fire protection material manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.

1.7 MOCKUPS

A. Build mockups [**to verify selections made under Sample submittals and to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**for preconstruction testing**].

1. Build mockup of [**each type of applied fire protection and different substrate**][**each required finish**] as indicated on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on[**field mockups of**] applied fire protection.

1. Provide test specimens and assemblies representative of proposed materials and construction.

B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.

1. Bond Strength: Test for cohesive and adhesive strength in accordance with ASTM E736/E736M. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum

specified in Part 2.

2. Density: Test for density in accordance with ASTM E605/E605M. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with applied fire protection material.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain applied fire protection material manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not apply applied fire protection when ambient or substrate temperature is [**44 deg F (7 deg C)**] or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain applied fire protection[**for each fire-resistance design**] from single source.

2.2 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide applied fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.

B. Fire-Resistance Design: Indicated on Drawings, tested in accordance with [**ASTM E119 or UL 263**]; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

C. VOC Content: For field applications, coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.

D. Low-Emitting Materials: For field applications, coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Field-applied coatings shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Flat Coatings: 50 g/L.
    b. Nonflat Coatings: 100 g/L.
    c. Primers, Sealers, and Undercoaters: 100 g/L.

F. Asbestos: Provide products containing no detectable asbestos.

2.3 SPRAYED FIRE-RESISTIVE MATERIALS

A. Sprayed Fire-Resistive Material: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and [**mixed with water at Project site to form a slurry or mortar before conveyance and application**][**conveyed in a dry state and mixed with atomized water at place of application**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carboline Company; a subsidiary of RPM International**]
    b. [**GCP Applied Technologies Inc.**]
    c. [**Isolatek International**]
    d. [**Southwest Fireproofing Products Co.**]

2. Application: Designated for exterior use by a qualified testing agency acceptable to authorities having jurisdiction.
3. Bond Strength: Minimum [**150-lbf/sq. ft. (7.18-kPa)**][**430-lbf/sq. ft. (20.59-kPa)**][**1000-lbf/sq. ft. (47.88-kPa)**] cohesive and adhesive strength based on field testing in accordance with ASTM E736/E736M.
4. Density: Not less than density specified in the approved fire-resistance design, in accordance with ASTM E605/E605M.
5. Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design or ASTM E605/E605M, whichever is thicker, but not less than **0.375 inch (9 mm)**.
6. Combustion Characteristics: ASTM E136.
7. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: [**10**] or less.
    b. Smoke-Developed Index: [**10**] or less.

8. Compressive Strength: Minimum [**10 lbf/sq. in. (68.9 kPa)**][**100 lbf/sq. in. (689 kPa)**][**300 lbf/sq. in. (2068 kPa)**] in accordance with ASTM E761/E761M.
9. Corrosion Resistance: No evidence of corrosion in accordance with ASTM E937/E937M.
10. Deflection: No cracking, spalling, or delamination in accordance with ASTM E759/E759.
11. Effect of Impact on Bonding: No cracking, spalling, or delamination in accordance with ASTM E760/E760M.
12. Air Erosion: Maximum weight loss of [**0.025 g/sq. ft. (0.270 g/sq. m)**] in 24 hours in accordance

with ASTM E859/E859M.

13. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in [**no growth on specimens per ASTM G21**][**rating of 10 in accordance with ASTM D3274 when tested in accordance with ASTM D3273**].
14. Sound Absorption: [**NRC**][**SAA**] of [**0.50 to 0.75**][**0.60 to 0.70**][**0.65 to 0.75**][**not less than 0.60**] in accordance with ASTM C423 for Type A mounting in accordance with ASTM E795.
15. Finish: [**As selected by Architect from manufacturer's standard finishes**][**Spray-textured finish**][**Rolled, spray-textured finish**][**Skip-troweled finish**][**Skip-troweled finish with corner beads**].[**Apply separate, colored topcoat after finishing.**]

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 AUXILIARY MATERIALS

A. Provide auxiliary materials that are compatible with sprayed fire-resistive material and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved in writing by sprayed fire-resistive material manufacturer and complying with one or both of the following requirements:

1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Primer's bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL's "Product iQ" online directory or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests in accordance with ASTM E736/E736M.

C. Bonding Agent: Product approved in writing by sprayed fire-resistive material manufacturer and complying with requirements in UL's "Product iQ" online directory or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, in accordance with fire-resistance designs indicated and sprayed fire-resistive material manufacturer's written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.

E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by sprayed fire-resistive material manufacturer.

F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by sprayed fire-resistive material manufacturer. Include pins and attachment.

G. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Isolatek International**]

H. Topcoat: Suitable for application over sprayed fire-resistive material; of type recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.

1. Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Carboline Company; a subsidiary of RPM International**]
2) [**Isolatek International**]

2. Water-Based Permeable Topcoat: Factory-mixed formulation for brush, roller, or spray application over applied SFRM. Provide application at a rate of [**30 sq. ft./gal. (0.75 sq. m/L)**][**60 sq. ft./gal. (1.5 sq. m/L)**][**120 sq. ft./gal. (3 sq. m/L)**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Isolatek International**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of applied fire protection with substrates under conditions of normal use or fire exposure.
2. Verify that objects penetrating applied fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Verify that substrates receiving applied fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

B. Verify that concrete work on steel deck is complete before beginning Work.

C. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning Work.

D. Conduct tests in accordance with sprayed fire-resistive material manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of applied fire protection materials during application.

B. Clean substrates of substances that could impair bond of applied fire protection.

C. Prime substrates where included in fire-resistance design and where recommended in writing by sprayed fire-resistive material manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive applied fire protection.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of applied fire protection. Remove minor projections and fill voids that would telegraph through applied fire protection after application.

3.3 APPLICATION

A. Construct applied fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting applied fire protection Work.

B. Comply with sprayed fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fire protection with other construction to minimize need to cut or remove applied fire protection.

1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.

D. Metal Decks:

1. Do not apply fire protection to underside of metal deck substrates until concrete topping, if any, is completed.
2. Do not apply fire protection to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fire protection.

E. Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and sprayed fire-resistive material manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer.

F. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by sprayed fire-resistive material manufacturer.

G. Extend applied fire protection in full thickness over entire area of each substrate to be protected.

H. Install body of applied fire protection in a single course unless otherwise recommended in writing by sprayed fire-resistive material manufacturer.

I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fire protection that differs in color from that of encapsulant over which it is applied.

J. Where sealers are used, apply products that are tinted to differentiate them from applied fire protection over which they are applied.

K. Provide a uniform finish complying with description indicated for each type of applied fire protection material and matching finish approved for required mockups.

L. Cure applied fire protection in accordance with sprayed fire-resistive material manufacturer's written instructions.

M. Do not install enclosing or concealing construction until after applied fire protection has been inspected, tested, and corrections have been made to deficient applications.

N. Finishes: Where indicated, apply fire protection to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish in accordance with manufacturer's written instructions for each finish selected.
2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.
4. Skip-Troweled Finish: Even leveled surface produced by troweling spray-applied finish to smooth out the texture and neaten edges.
5. Skip-Troweled Finish with Corner Beads: Even, leveled surface produced by troweling spray-applied finish to smooth out the texture, eliminate surface markings, and square off edges.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC[**Subsection 1705.15, "Sprayed Fire-Resistant Materials."**][**as indicated on Schedule of Special Inspections.**]

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Applied fire protection will be considered defective if it does not pass tests and inspections.

1. Remove and replace applied fire protection that does not pass tests and inspections, and retest.
2. Apply additional applied fire protection, in accordance with manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.5 CLEANING

A. Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 PROTECTION

A. Protect applied fire protection from damage resulting from construction operations or other causes in accordance with manufacturer's and Installer's written instructions, so applied fire protection is without damage or deterioration at time of Substantial Completion.

3.7 REPAIRS

A. As installation of other adjacent construction proceeds, inspect applied fire protection and repair damaged areas due to work of other trades before concealing it with other construction.

B. Repair applied fire protection using same method and materials as original installation or using manufacturer's recommended trowel-applied repair product.

END OF SECTION 07 81 00 00

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Task	Specification	Specification Description
07 81 16 00	07 81 00 00	Applied Fire Protection

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SECTION 07 81 23 00 - INTUMESCENT FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mastic and intumescent fire-resistive coatings.

B. Related Requirements:

1. Section 078100 "Applied Fire Protection" for sprayed fire-resistive materials (SFRM).
2. Section 099646 "Intumescent Painting" for intumescent paints that are fire retarding, but not fire resistive.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review products, design ratings, restrained and unrestrained conditions, thicknesses, and other performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Mastic and intumescent fire-resistive coatings.
2. Substrate primers.
3. Reinforcing fabric.
4. Reinforcing mesh.
5. Topcoat.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

C. Shop Drawings: Framing plans or schedules, or both, indicating the following:

1. Extent of fire protection for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency

acceptable to authorities having jurisdiction.
3. Minimum mastic and intumescent fire-resistive coating thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of mastic and intumescent fire-resistive coating after application.

D. Samples: For each exposed product and for each color and texture specified, [**in manufacturer's standard dimensions**][**4 inches (102 mm) square**] in size.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**testing agency**].

B. Product Certificates: For each type of mastic and intumescent fire-resistive coating.

C. Evaluation Reports: For mastic and intumescent fire-resistive coating, from ICC-ES.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by mastic and intumescent fire-resistive coating manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.

B. Mockups: Build mockups [**to verify selections made under Sample submittals and to demonstrate aesthetic effects**][**to set quality standards for materials and execution**].

1. Build mockup of [**each type of fire protection and different substrate**][**each required finish**] as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is [**50 deg F (10 deg C)**] or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fire protection[**for each fire-resistance design**] from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested in accordance with [**ASTM E119 or UL 263**]; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content, LEED 2009: For field applications, coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.

E. Low-Emitting Materials, LEED 2009: Coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. VOC Content, LEED v4: For field applications, coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.

G. Low-Emitting Materials, LEED v4: For field applications, coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Material Emissions and Pollutant Control: Field-applied coatings shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

a. Flat Coatings: 50 g/L.
b. Nonflat Coatings: 100 g/L.
c. Primers, Sealers, and Undercoaters: 100 g/L.

I. Emissions Requirements: Field-applied coatings shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

a. Flat Coatings: 50 g/L.
b. Nonflat Coatings: 100 g/L.
c. Primers, Sealers, and Undercoats: 100 g/L.

J. Asbestos: Provide products containing no detectable asbestos.

2.2 MASTIC AND INTUMESCENT FIRE-RESISTIVE COATINGS

A. Mastic and Intumescent Fire-Resistive Coating: Manufacturer's standard, [**factory-mixed formulation**][**factory-mixed, multicomponent system consisting of intumescent base coat and topcoat**], and complying with indicated fire-resistance design.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Albi Protective Coatings**]
b. [**Carboline Company; a subsidiary of RPM International**]
c. [**Contego International, Inc.**]
d. [**FlameOff Coatings, Inc.**]
e. [**Hilti, Inc.**]
f. [**International Protective Coatings; AkzoNobel**]
g. [**Isolatek International**]
h. [**PPG Paints; PPG Industries, Inc.**]
i. [**Sherwin-Williams Company (The)**]

2. Application: Designated for [**"exterior"**][**"interior general purpose"**][**"conditioned interior space purpose"**] use by a qualified testing agency acceptable to authorities having jurisdiction.
3. Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design.
4. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**25**] or less.
b. Smoke-Developed Index: [**50**][**450**] or less.

5. Hardness: Not less than [**45**][**65**][**80**], Type D durometer, in accordance with ASTM D2240.
6. Finish: [**As selected by Architect from manufacturer's standard finishes**][**Spray-textured finish**][**Rolled, spray-textured finish**].

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that are compatible with mastic and intumescent fire-resistive coating and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by mastic and intumescent fire-resistive coating manufacturer and complying with required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by mastic and intumescent fire-resistive coating manufacturer.

D. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by mastic and intumescent fire-resistive coating manufacturer. Include pins and attachment.

E. Topcoat: Suitable for application over mastic and intumescent fire-resistive coating; of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer for each fire-resistance design.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

B. Conduct tests in accordance with mastic and intumescent fire-resistive coating manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.

B. Clean substrates of substances that could impair bond of fire protection.

C. Prime substrates where included in fire-resistance design and where recommended in writing by mastic and intumescent fire-resistive coating manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, topcoats, finishing, and other

materials and procedures affecting fire protection Work.

B. Comply with mastic and intumescent fire-resistive coating manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.

1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.

D. Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and mastic and intumescent fire-resistive coating manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

E. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

F. Extend fire protection in full thickness over entire area of each substrate to be protected.

G. Install body of fire protection in a single course unless otherwise recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

H. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.

I. Cure fire protection in accordance with mastic and intumescent fire-resistive coating manufacturer's written instructions.

J. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

K. Finishes: Where indicated, apply fire protection to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish in accordance with manufacturer's written instructions for each finish selected.
2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC[**, Subsection 1705.14, "Mastic and Intumescent Fire-Resistant Coatings."**][**as indicated on Schedule of Special Inspections.**]

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fire protection will be considered defective if it does not pass tests and inspections.

1. Remove and replace fire protection that does not pass tests and inspections, and retest.
2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.5 CLEANING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 PROTECTION

A. Protect fire protection, in accordance with advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

3.7 REPAIRS

A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.

B. Repair fire protection damaged by other work before concealing it with other construction.

C. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

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Task	Specification	Specification Description
07 81 23 00	07 81 00 00	Applied Fire Protection
07 81 33 00	07 81 00 00	Applied Fire Protection

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SECTION 07 84 13 00 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Penetration firestopping systems.

1. Penetration firestopping systems in fire-resistance-rated walls.
2. Penetration firestopping systems in horizontal assemblies.
3. Penetration firestopping systems in smoke barriers.
4. Exposed penetration firestopping systems.

B. Related Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.
2. Section 079200 "Joint Sealants" for non-fire-resistance-rated joint sealants.
3. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

C. Unlisted Firestopping Systems: Obtain an Engineering Judgment (EJ) from firestopping manufacturer where no UL, FM Approvals, or other listed assembly is available for particular firestop configuration. Follow International Firestop Council (IFC) recommended guidelines for evaluating firestopping systems in EJs.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) recommended guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

D. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Entity that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL Solutions and found to comply with "UL Solutions Qualified Firestop Contractor Program."

B. Manufacturer Qualifications: Entity that has received UL Solutions' "Firestop Movement Certification," which demonstrates that manufacturer's firestopping products designated with M-Ratings are based on exposure to cyclic movement and UL 1479 fire test evaluation when tested in accordance with ASTM E3037.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of each penetration firestopping system type required for Project, including supporting construction substrates, attachments, and accessories.
2. Where one penetration firestopping system type may be used for different penetrating items or in different wall or floor constructions, install one assembly for each different combination.
3. Obtain approval of mockups from authorities having jurisdiction before proceeding.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping systems when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping system materials in accordance with manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be accessed and installed in accordance with specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain penetration firestopping systems for each type of opening indicated from single manufacturer.

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M Building and Construction**]
2. [**Balco; a CSW Industrials Company**]
3. [**Everkem Diversified Products, Inc.**]
4. [**FireShield; Fire Rated Solutions LLC**]
5. [**Grabber Construction Products, Inc.**]
6. [**Hilti, Inc.**]
7. [**Holdrite; a division of Reliance Worldwide Corporation**]
8. [**International Fireproof Technology Inc**]
9. [**NUCO Inc**]
10. [**Passive Fire Protection Partners**]
11. [**Roxtec Inc.**]
12. [**Specified Technologies Inc.**]
13. [**STC Sound Control**]
14. [**Tremco Incorporated**]
15. [**Unique Fire Stop Products**]

B. Penetration firestopping systems must be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Penetration firestopping systems must be installed with products bearing the classification marking of a qualified testing agency.

    a. UL Solutions in its online directory "Product iQ."
    b. Intertek Group in its "Directory of Building Products."
    c. FM Approvals in its "Approval Guide."

2. Provide components for each penetration firestopping system that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during and after construction.
3. Provide components for each penetration firestopping system that do not contain ethylene glycol.
4. Provide components for each penetration firestopping system that are sufficiently flexible to accommodate movement, such as pipe vibration, water hammer, thermal expansion, and other normal building movement without damage.
5. Provide components for each penetration firestopping system that are appropriately tested for the thickness and type of insulation utilized.

C. Provide penetration firestopping systems that resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

D. Penetration Firestopping Systems in Fire-Resistance-Rated Walls: Systems with ratings determined in accordance with ASTM E814 or UL 1479.

1. F-Rating: Not less than the fire-resistance rating of the wall assembly penetrated.
2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
3. M-Rating: Provide penetration firestopping systems meeting specified F-Rating after being tested in accordance with ASTM E3037.

E. Penetration Firestopping Systems in Horizontal Assemblies: Systems with ratings determined in accordance with ASTM E814 or UL 1479.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor/ceiling assembly penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor/ceiling assembly. The following horizontal penetrations do not require a T-rating:

    a. Those within the cavity of a wall.
    b. Floor, tub, or shower drains within a concealed space.
    c. **4-inch (200-mm)** or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.

3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.
4. M-Rating: Provide penetration firestopping systems meeting specified [**F-Rating,**][**T-Rating,**][**W-Rating**] after being tested in accordance with ASTM E3037.

F. Penetration Firestopping Systems in Smoke Barriers: Systems with ratings determined in accordance with UL 1479.

1. L-Rating: Not exceeding **5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m)** of penetration opening and no more than **50-cfm (0.024-cu. m/s)** cumulative total for any **100 sq. ft. (9.3 sq. m)** at both ambient and elevated temperatures.
2. M-Rating: Provide penetration firestopping systems meeting specified L-Rating after being tested in accordance with ASTM E3037.

G. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84 or UL 723.

1. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.
2. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.3 ACCESSORIES

A. Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated, including but not limited to:

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.4 FILL MATERIALS

A. Cast-in-Place Firestopping Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestopping Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, and when required by a listed system, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed or dislodged.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

K. Thermal and Endothermic Wraps: Flexible, insulating, and fire-resistant protective wraps tested and listed for up to 2-hour fire ratings in accordance with ASTM E814 or UL 1479; for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines, and for thermal barrier and circuit integrity protection in accordance with ASTM E1725 or UL 1724.

L. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls which accept standard accessories.

M. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.

1. Fire-rated cable pathway devices are the preferred product for data, video, and communications cable penetrations. Install these devices in locations where frequent cable moves, add-ons, and changes will occur. Such devices must be:

   a. Capable of retrofit around existing cables.
   b. Designed so that two or more devices can be ganged together.
   c. Maintenance-free so no action is required to activate the smoke- and fire-sealing mechanism.

2. Where fire-rated cable pathway devices are not practical, openings within walls and floors designed to accommodate data, video, and communications cabling must be provided with re-enterable products specifically designed for retrofit, such as retrofit devices for cable bundles, firestopping putty, plugs, or pillows.

N. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.

O. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.

P. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestopping gasket for use around rectangular steel HVAC ducts without fire dampers.

Q. Firestopping Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.

R. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to **1/2 inch (13 mm)** in diameter.

S. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.

2.5 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings in accordance with manufacturer's written instructions and with the following requirements:

1. Remove foreign materials from substrate surfaces that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates in accordance with penetration firestopping system manufacturer's written installation instructions, using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

A. General: Install penetration firestopping systems in accordance with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than **3 inches (76 mm)** high and with minimum **0.375-inch (9.5-mm)** strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at **15 ft. (4.57 m)** from end of wall and at intervals not exceeding **30 ft. (9.14 m)**.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within **6 inches (150 mm)** of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of

permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. the Owner will engage a qualified inspection agency to conduct and report on inspections in accordance with ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 07 84 13 00

Task	Specification	Specification Description
07 84 13 16	07 84 13 00	Penetration Firestopping
07 84 13 16	07 84 43 00	Joint Firestopping
07 84 13 19	07 84 13 00	Penetration Firestopping
07 84 13 19	07 84 43 00	Joint Firestopping
07 84 16 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 07 84 43 00 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Intumescent gypsum wall framing gaskets.
2. Perimeter fire-barrier system.
3. Joints in or between fire-resistance-rated construction.
4. Joints at exterior curtain-wall/floor intersections.
5. Joints in smoke barriers.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers[**and for wall identification**].
2. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
3. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
4. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies subject to vehicular traffic.
5. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Unlisted Firestopping Systems: Obtain an Engineering Judgment (EJ) from firestop manufacturer where no UL, FM Approvals, or other listed assembly is available for particular firestop configuration. Follow International Firestop Council (IFC) recommended guidelines for evaluating firestop systems in EJs.

C. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an EJ or equivalent fire-resistance-rated assembly developed in accordance with current IFC guidelines.

D. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written installation instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL and found to comply with UL's "UL Solutions Qualified Firestop Contractor Program."

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems in accordance with manufacturer's written installation instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed in accordance with specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. A qualified testing agency, acceptable to authorities having jurisdiction, will perform joint firestopping system tests.
2. Test in accordance with testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."
2) Intertek Group in its "Directory of Building Products."

B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.3 JOINT FIRESTOPPING SYSTEM TYPES

A. General: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
3. Provide firestop products that do not contain ethylene glycol.

B. Intumescent Gypsum Wall Framing Gaskets: Applied to steel tracks, runners, and studs prior to framing installation. Provide products with fire, smoke, and acoustical ratings that allow movement of up to 100 percent compression and/or extension when tested in accordance with UL 2079 or ASTM E1966; have an L Rating of less than **1 cfm/ft. (0.00115 cu. m/s x m)** when tested in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 when tested in accordance with ASTM E90 or ASTM C919.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**International Fireproof Technology Inc**]
d. [**Specified Technologies Inc.**]

C. Perimeter Fire-Barrier System: Provide perimeter fire-barrier system that does not require direct screw

attachment to mullions and transoms to support and fasten curtain-wall insulation for aluminum curtain-wall assemblies with one- or two-piece rectangular mullions at least **2-1/2 by 5 inches (64 by 127 mm)**. System will be tested in accordance with ASTM E2307 for up to two-hour fire resistance and with ASTM E1233/E1233M for wind cycling equivalent to **108 mph (174 km/h)** wind for 500 cycles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CEMCO; California Expanded Metal Products Co.**]
    b. [**Grabber Construction Products, Inc.**]
    c. [**Specified Technologies Inc.**]

D. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined in accordance with ASTM E1966 or UL 2079, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the fire-resistive joint system to restrict the movement of smoke.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**3M Building and Construction**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**CEMCO; California Expanded Metal Products Co.**]
    d. [**ClarkDietrich**]
    e. [**Everkem Diversified Products, Inc.**]
    f. [**Grabber Construction Products, Inc.**]
    g. [**Hilti, Inc.**]
    h. [**International Fireproof Technology Inc**]
    i. [**Marino\WARE**]
    j. [**Nelson; Emerson Electric Co., Automation Solutions**]
    k. [**NUCO Inc**]
    l. [**Owens Corning**]
    m. [**Passive Fire Protection Partners**]
    n. [**RectorSeal Firestop; a CSW Industrials Company**]
    o. [**ROCKWOOL**]
    p. [**Specified Technologies Inc.**]
    q. [**Tremco Incorporated**]
    r. [**Willseal LLC, part of Tremco CPG**]

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

E. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined in accordance with ASTM E2307.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**3M Building and Construction**]
b. [**Balco; a CSW Industrials Company**]
c. [**Everkem Diversified Products, Inc.**]
d. [**Grabber Construction Products, Inc.**]
e. [**Hilti, Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Nelson; Emerson Electric Co., Automation Solutions**]
h. [**NUCO Inc**]
i. [**Owens Corning**]
j. [**RectorSeal Firestop; a CSW Industrials Company**]
k. [**ROCKWOOL**]
l. [**Specified Technologies Inc.**]
m. [**Tremco Incorporated**]

2. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

F. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined in accordance with UL 2079 based on testing at a positive pressure differential of **0.30 inch wg (74.7 Pa)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**3M Building and Construction**]
b. [**Balco; a CSW Industrials Company**]
c. [**CEMCO; California Expanded Metal Products Co.**]
d. [**Everkem Diversified Products, Inc.**]
e. [**Grabber Construction Products, Inc.**]
f. [**Hilti, Inc.**]
g. [**International Fireproof Technology Inc**]
h. [**Marino\WARE**]
i. [**Nelson; Emerson Electric Co., Automation Solutions**]
j. [**NUCO Inc**]
k. [**Owens Corning**]
l. [**Passive Fire Protection Partners**]
m. [**Polyset**]
n. [**RectorSeal Firestop; a CSW Industrials Company**]
o. [**Specified Technologies Inc.**]
p. [**Tremco Incorporated**]
q. [**Willseal LLC, part of Tremco CPG**]

2. L-Rating: Not exceeding **5.0 cfm/ft. (0.00775 cu. m/s x m)** of joint at both ambient and elevated temperatures.

G. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined in accordance with ASTM E84.

1. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.4 ACCESSORIES

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing joint firestopping systems, clean joints in accordance with fire-resistive joint system manufacturer's written installation instructions and the following requirements:

1. Remove foreign materials from substrate surfaces that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates in accordance with joint firestopping system manufacturer's written installation instructions, using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Apply a suitable bond breaker to prevent three-sided adhesion in applications where condition occurs.

3.3 INSTALLATION

A. General: Install joint firestopping systems in accordance with manufacturer's written installation

instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Apply elastomeric fill in voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than **3 inches (76 mm)** high and with minimum **0.375-inch (9.5-mm)** strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at **15 ft. (4.57 m)** from end of wall and at intervals not exceeding **30 ft. (9.14 m)**.

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within **6 inches (150 mm)** of joint edge, so labels are visible to anyone seeking to remove joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. the Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.7 JOINT FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's online directory "Product iQ" under product [**Category XHBN**][**Category XHDG**].

B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Building Products" under product category [**Expansion/Seismic Joints**][**Firestop Systems**].

C. Floor-to-Floor, Joint Firestopping Systems: .

1. UL-Classified Systems: FF-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].
4. W-Rating: No leakage of water at completion of water-leakage testing.

D. Wall-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: WW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

E. Floor-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: FW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

F. Head-of-Wall, Fire-Resistive Joint Firestopping Systems:

1. UL-Classified Systems: HW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

G. Bottom-of-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: BW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

H. Wall-to-Wall, Joint Firestopping Systems Intended for Use as Corner Guards:

1. UL-Classified Systems: CG-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

I. Perimeter Joint Firestopping Systems:

1. UL-Classified Perimeter Fire-Containment Systems: CW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**].
2. Integrity Rating: [**One hour**][**Two hours**].
3. Insulation Rating: [**Zero hour**][**1/4 hour**][**3/4 hour**][**1 hour**].
4. Linear Opening Width: [**2-1/2 inches (64 mm)**][**8 inches (203 mm)**][**As indicated**], maximum.
5. F-Rating: [**One hour**][**Two hours**].

END OF SECTION 07 84 43 00

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Task	Specification	Specification Description
07 84 43 00	07 84 13 00	Penetration Firestopping
07 86 00 00	07 84 13 00	Penetration Firestopping
07 86 00 00	07 84 43 00	Joint Firestopping

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SECTION 07 91 00 00 - PREFORMED JOINT SEALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preformed, foam joint seals.
2. Extruded-silicone joint seals.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for liquid sealants applied over preformed seals in dual-seal systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Preformed, foam joint seals.
2. Extruded-silicone joint seals.

B. Samples for Initial Selection: Manufacturer's color sheets, showing full range of available colors for each type of exposed preformed joint seal.

C. Samples for Verification: Actual samples of each type and color of exposed preformed joint seal.

1. Size: **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint seals.

D. Preformed Joint Seal Schedule: Include the following information:

1. Joint seal location and designation.
2. Joint width and movement capability.
3. Joint seal manufacturer and product name.
4. Joint seal color.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each preformed joint seal, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Sample warranties.

1.5 MOCKUPS

A. Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**and**][**to set quality standards for materials and execution**].

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace preformed joint seals that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish preformed joint seals to repair or replace those that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For preformed joint seals, obtain each color, type, and variety of joint seal from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PREFORMED, FOAM JOINT SEALS

A. Preformed, Foam Joint Seals : Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of **10 lb/cu. ft. (160 kg/cu. m)** and impregnated with a nondrying, water-repellent agent. Factory produce them in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EMSEAL; a Sika Company**]
b. [**LymTal International, Inc.**]
c. [**MM Systems Corporation**]
d. [**Nystrom, Inc.**]
e. [**Pecora Corporation**]
f. [**Schul International Company, LLC**]

g. [**Watson Bowman Acme Corp.**]
h. [**Willseal LLC, part of Tremco CPG**]

2. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.3 EXTRUDED-SILICONE JOINT SEALS

A. Extruded-Silicone Joint Seals : Manufacturer's standard seal consisting of precured low-modulus silicone extrusion, with a neutral-curing silicone sealant for bonding extrusions to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
b. [**Nystrom, Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation**]
e. [**The Dow Chemical Company**]
f. [**Tremco Incorporated**]

2. Joint Seal Width: [**4 inches (102 mm)**][**Joint size indicated on Drawings plus 3/4 inch (19 mm)**][**Joint size indicated on Drawings plus 1 inch (25 mm)**]
3. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by preformed joint seal manufacturer for joint substrates indicated.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to preformed joint seal manufacturer, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces, and formulated to promote best adhesion to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with preformed joint seals and surfaces adjacent to joints.

D. Sealant for Adhering Extruded-Silicone Joint Seals: Silicone adhesive sealant recommended by extruded-silicone joint seal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive preformed joint seals, with Installer present, for compliance with

requirements for joint configuration, installation tolerances, and other conditions affecting preformed joint seal performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing preformed joint seals to comply with preformed joint seal manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of preformed joint seal, including dust, paints (except for permanent protective coatings tested and approved for seal adhesion and compatibility by seal manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimal bond with preformed joint seals. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint seals. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by preformed joint seal manufacturer or as indicated by tests or prior experience. Apply primer to comply with joint seal manufacturer's written instructions. Confine primers to areas of joint seal bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of adhesive or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF PREFORMED, FOAM JOINT SEALS

A. General: Comply with preformed joint seal manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.

3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

3.4 INSTALLATION OF EXTRUDED-SILICONE JOINT SEALS

A. General: Comply with preformed joint seal manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

1. Apply masking tape to each side of joint, outside of area to be covered by seal system.
2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone seal system manufacturer's written instructions and covering a bonding area of not less than **3/8 inch (10 mm)**. Hold edge of sealant bead **1/4 inch (6 mm)** inside masking tape.
3. Press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact with substrate.
4. Complete installation of seal system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

3.5 PROTECTION

A. Protect preformed joint seals from damage resulting from construction operations or other causes so seals are without deterioration or damage at time of Substantial Completion.

B. Cut out, remove, and repair damaged or deteriorated seals so repaired areas are indistinguishable from original work.

END OF SECTION 07 91 00 00

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Task	Specification	Specification Description
07 91 23 00	07 91 00 00	Preformed Joint Seals
07 91 23 00	07 92 00 00	Joint Sealants
07 91 26 00	07 91 00 00	Preformed Joint Seals
07 91 26 00	07 92 00 00	Joint Sealants
07 91 33 00	07 91 00 00	Preformed Joint Seals

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SECTION 07 92 00 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

B. Related Requirements:

1. Section 079100 "Preformed Joint Seals" for preformed compressible foam and precured joint seals.
2. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.
3. Section 321373 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:

1. Joint-sealant location and designation.
2. Manufacturer and product name.
3. Type of substrate material.
4. Proposed test.
5. Number of samples required.

B. Preconstruction Laboratory Test Reports: For each joint sealant and substrate material to be tested from sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

D. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturers' special warranties.

B. Installer's special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 MOCKUPS

A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint

sealants specified in this Section. Use materials and installation methods specified in this Section.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with [**stone**][**masonry**] substrates.
4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect, as directed by the Owner.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected, as directed by the Owner.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
5. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.

    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

6. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.9 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below 40 deg F (5 deg C)**].
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.10 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer[**for each sealant type**].

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Sika Corporation - Building Components**]

B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation - Building Components**]
e. [**The Dow Chemical Company**]

C. Silicone, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability. nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Premier Building Solutions**]
d. [**Sika Corporation - Building Components**]
e. [**The Dow Chemical Company**]

D. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
b. [**Pecora Corporation**]
c. [**Permathane; a Holcim brand**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]
f. [**Sika Corporation - Building Components**]
g. [**The Dow Chemical Company**]

E. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Bostik; Arkema**]
c. [**Everkem Diversified Products, Inc.**]
d. [**Pecora Corporation**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**PPG Paints; PPG Industries, Inc.**]
g. [**Premier Building Solutions**]
h. [**Sika Corporation - Building Components**]
i. [**The Dow Chemical Company**]

F. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pecora Corporation**]
b. [**The Dow Chemical Company**]

G. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Soudal Accumetric**]
b. [**The Dow Chemical Company**]

H. Silicone, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Pecora Corporation**]
b. [**Sika Corporation - Building Components**]

I. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pecora Corporation**]

J. Silicone, M, P, 100/50, T, NT: Multicomponent, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade P, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**The Dow Chemical Company**]

2.4 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Pecora Corporation**]
c. [**Sika Corporation - Building Components**]
d. [**Tremco Incorporated**]

C. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation - Building Components**]
e. [**Soudal Accumetric**]
f. [**The Dow Chemical Company**]
g. [**Tremco Incorporated**]

D. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**The Dow Chemical Company**]

E. Silicone, Nonstaining, M, NS, 50, NT: Nonstaining, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

2.5 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Bostik; Arkema**]
c. [**Everkem Diversified Products, Inc.**]
d. [**Master Builders Solutions**]
e. [**Pecora Corporation**]
f. [**Permathane; a Holcim brand**]
g. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
h. [**PPG Paints; PPG Industries, Inc.**]

i. [**Sherwin-Williams Company (The)**]
j. [**Sika Corporation - Building Components**]
k. [**Tower Sealants, Inc.**]
l. [**Tremco Incorporated**]

B. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

C. Urethane, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]
b. [**Master Builders Solutions**]

D. Urethane, S, P, 35, T, NT: Single-component, pourable, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 35, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]

E. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Pecora Corporation**]
c. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
d. [**Sherwin-Williams Company (The)**]

F. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Pecora Corporation**]

G. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Sherwin-Williams Company (The)**]

H. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

I. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**LymTal International, Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]

J. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]

K. Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**LymTal International, Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]
e. [**Sherwin-Williams Company (The)**]
f. [**Tremco Incorporated**]

2.6 IMMERSIBLE JOINT SEALANTS

A. Immersible Joint Sealants: Suitable for immersion in liquids; ASTM C1247, [**Class 1**][**Class 2**]; tested in deionized water unless otherwise indicated.

B. Urethane, Immersible, S, NS, 100/50, NT, I: Immersible, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

C. Urethane, Immersible, S, NS, 35, NT, I: Immersible, single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]

D. Urethane, Immersible, S, NS, 50, T, NT, I: Immersible, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

E. Urethane, Immersible, S, NS, 35, T, NT, I: Immersible, single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]

F. Urethane, Immersible, S, NS, 25, T, NT, I: Immersible, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Pecora Corporation**]
c. [**Tremco Incorporated**]

G. Urethane, Immersible, S, P, 50, T, NT, I: Immersible, single-component, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

H. Urethane, Immersible, S, P, 25, T, NT, I: Immersible, single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]
b. [**W. R. Meadows, Inc**]

I. Polysulfide, Immersible, M, NS, 25, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and

minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]

J. Urethane, Immersible, M, NS, 50, T, NT, I: Immersible, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**LymTal International, Inc.**]
    b. [**Tremco Incorporated**]

K. Urethane, Immersible, M, NS, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Master Builders Solutions**]

L. Polysulfide, Immersible, M, NS, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Pecora Corporation**]

M. Urethane, Immersible, M, P, 25, T, NT, I: Immersible, multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]
b. [**Master Builders Solutions**]

2.7 SILANE-MODIFIED POLYMER JOINT SEALANTS

A. Silane-Modified Polymer, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]
e. [**Premier Building Solutions**]
f. [**Sherwin-Williams Company (The)**]
g. [**Sika Corporation - Building Components**]
h. [**Soudal Accumetric**]

B. Silane-Modified Polymer, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Premier Building Solutions**]
c. [**Sika Corporation - Building Components**]
d. [**Tremco Incorporated**]

C. Silane-Modified Polymer, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Everkem Diversified Products, Inc.**]
b. [**Franklin International**]
c. [**Permathane; a Holcim brand**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**Sika Corporation - Building Components**]

D. Silane-Modified Polymer, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 100, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Soudal Accumetric**]
    b. [**Sto Corp.**]

E. Silane-Modified Polymer, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Franklin International**]
    b. [**Soudal Accumetric**]

F. Silane-Modified Polymer, S, NS, 35, T, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Soudal Accumetric**]

G. Silane-Modified Polymer, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Soudal Accumetric**]

H. Silane-Modified Polymer, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Franklin International**]
    b. [**Premier Building Solutions**]
    c. [**Soudal Accumetric**]

2.8 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Adfast**]
    b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
    c. [**Pecora Corporation**]
    d. [**PPG Paints; PPG Industries, Inc.**]
    e. [**Sika Corporation - Building Components**]
    f. [**Soudal Accumetric**]
    g. [**The Dow Chemical Company**]
    h. [**Tremco Incorporated**]

C. Silane-Modified Polymer, Mildew Resistant, S, NS, 50, NT: Mildew-resistant, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Master Builders Solutions**]

2.9 POLYSULFIDE JOINT SEALANTS

A. Polysulfide, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**W. R. Meadows, Inc**]

B. Polysulfide, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**W. R. Meadows, Inc**]

C. Polysulfide, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**W. R. Meadows, Inc**]

2.10 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bostik; Arkema**]
    b. [**Everkem Diversified Products, Inc.**]
    c. [**GSSI Sealants**]
    d. [**Pecora Corporation**]
    e. [**Sika Corporation - Building Components**]

2.11 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**Everkem Diversified Products, Inc.**]
c. [**Franklin International**]
d. [**Pecora Corporation**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. [**Tremco Incorporated**]

2.12 JOINT-SEALANT BACKING

A. Sealant Backing Material: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Alcot Plastics Ltd.**]
c. [**Construction Foam Products; a division of Nomaco, Inc.**]
d. [**Master Builders Solutions**]

B. Cylindrical Sealant Backings: ASTM C1330, [**Type C (closed-cell material with a surface skin)**][**Type O (open-cell material)**][**Type B (bicellular material with a surface skin)**][**or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated**], and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.13 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at [**locations indicated on Drawings**] in accordance with Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and at [**locations indicated on Drawings**] in accordance with Figure 8C in ASTM C1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

a. Extent of Testing: Test completed and cured sealant joints as follows:

1) Perform [**10**] tests for the first [**1000 ft. (300 m)**] of joint length for each kind of sealant and joint substrate.
2) Perform one test for each [**1000 ft. (300 m)**] of joint length thereafter or one test per each floor per elevation.

b. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

c. Inspect tested joints and report on the following:

1) Whether sealants filled joint cavities and are free of voids.
2) Whether sealant dimensions and configurations comply with specified requirements.
3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

C. Prepare test and inspection reports.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

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Task	Specification	Specification Description
07 92 13 00	07 92 00 00	Joint Sealants

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SECTION 07 92 19 00 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Acoustical joint sealants.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for nonacoustical applications.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants, showing full range of available colors for each product exposed to view.

C. Samples for Verification: For each type and color of acoustical joint sealant required.

1. Size: **1/2-inch- (13-mm-)** wide sealant joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Acoustical Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

E. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each type of acoustical joint sealant, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained between **40 and 95 deg F (4 and 35 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between [**35 and 100 deg F (2 and 38 deg C)**][**60 and 90 deg F (16 and 32 deg C)**].[**Warm surfaces to be coated to 70 deg F (21 deg C) to enhance drying.**]

1.7 WARRANTY

A. Installer's Special Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Manufacturer's Special Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

PART 2 - PRODUCTS

2.1 ACOUSTICAL JOINT SEALANTS

A. Acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies in accordance with ASTM E90.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DAP Products Inc.**]
b. [**Everkem Diversified Products, Inc.**]
c. [**Franklin International**]
d. [**Grabber Construction Products, Inc.**]
e. [**Hilti, Inc.**]
f. [**OSI Sealants; Henkel Corporation**]
g. [**Pecora Corporation**]
h. [**Specified Technologies Inc.**]

2. Colors of Exposed Acoustical Joint Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

C. Acoustical Sealant for Concealed Joints: Manufacturer's standard nonsag, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber acoustical sealant.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**OSI Sealants; Henkel Corporation**]
b. [**Pecora Corporation**]
c. [**Tremco Incorporated**]
d. [**USG Corporation**]

2.2 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by acoustical joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written instructions for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage

or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 92 19 00

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Task	Specification	Specification Description
07 92 19 00	07 92 00 00	Joint Sealants

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SECTION 07 95 13 00 - PARKING DECK EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Parking deck expansion joint covers.

B. Related Requirements:

1. Section 079100 "Preformed Joint Seals" for preformed foam and extruded-silicone joint seals.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Parking deck expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.
6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement: As indicated on Drawings.

2.3 PARKING DECK EXPANSION JOINT COVERS

A. Metal-Plate Parking Deck Joint Cover : Assembly consisting of metal cover plate in continuous contact with metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**LymTal International, Inc.**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]
i. [**Willseal LLC, part of Tremco CPG**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Installation: [**Surface mounted**][**Recessed**][**No bump**].
4. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

   a. Aluminum: [**Mill**][**Manufacturer's standard**].
   b. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

B. T-Joint Parking Deck Joint Cover : Assembly consisting of factory-formed polyurethane block with tapered edges over steel plate. Provide manufacturer's standard, liquid-applied nosing sealant for preformed voids at tapered edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Balco; a CSW Industrials Company**]
   b. [**Erie Metal Specialties, Inc.**]
   c. [**LymTal International, Inc.**]
   d. [**MM Systems Corporation**]
   e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Exposed Metal:

a. Aluminum: [**Mill**][**Manufacturer's standard**].
b. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

6. Polyurethane Block:

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Compression-Seal Parking Deck Joint Cover : Complying with ASTM E1612/E1612M. Elastomeric seal designed to always stay in compression. Install using manufacturer's recommended lubricant adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**D.S. Brown; a Gibraltar Industries company**]
e. [**Erie Metal Specialties, Inc.**]
f. [**inpro Corporation**]
g. [**LymTal International, Inc.**]
h. [**MM Systems Corporation**]
i. [**Nystrom, Inc.**]
j. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Precompressed Foam Parking Deck Expansion Joint Seals : Manufacturer's precompressed, self-expanding foam joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam, impregnated with a nondrying, water-repellent agent, and coated with traffic-grade silicone wearing surface. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Balco; a CSW Industrials Company**]
b. [**EMSEAL; a Sika Company**]

c. [**Willseal LLC, part of Tremco CPG**]

2. Design Criteria:

   a. Nominal Joint Width: [**As indicated on Drawings**].
   b. Minimum Joint Width: [**As indicated on Drawings**].
   c. Maximum Joint Width: [**As indicated on Drawings**].

3. Application: Slab to slab.
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Joint Seal Color: [**Gray**][**As indicated by manufacturer's designations**].

E. Epoxy-Bonded-Seal Parking Deck Joint Covers : Elastomeric seal, epoxy-bonded to sides of joint gap. Install using manufacturer's recommended epoxy adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**D.S. Brown; a Gibraltar Industries company**]
   e. [**Erie Metal Specialties, Inc.**]
   f. [**LymTal International, Inc.**]
   g. [**MM Systems Corporation**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Strip-Seal Parking Deck Joint Covers : Complying with ASTM E1783/E1783M. Assembly consisting of elastomeric seal mechanically locked into a metal frame or edge rails cast into slab edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**D.S. Brown; a Gibraltar Industries company**]
   b. [**Erie Metal Specialties, Inc.**]

c. [**inpro Corporation**]
d. [**LymTal International, Inc.**]
e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Winged-Seal Parking Deck Joint Covers : Winged elastomeric seal grouted into block outs without mechanical attachment. Fully grout block out with manufacturer's elastomeric concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**D.S. Brown; a Gibraltar Industries company**]
e. [**EMSEAL; a Sika Company**]
f. [**Erie Metal Specialties, Inc.**]
g. [**inpro Corporation**]
h. [**LymTal International, Inc.**]
i. [**MM Systems Corporation**]
j. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Bolt-In Parking Deck Joint Cover : Assembly consisting of winged elastomeric seal locked into slab-edge block outs by metal frames bolted to slab. Fully grout block outs with elastomeric concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**LymTal International, Inc.**]
    d. [**MM Systems Corporation**]
    e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

    a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
    b. Concentrated Load: [**2000 lb (907 kg)**].
    c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

    a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Split-Slab Membrane Parking Deck Joint Cover : Designed for use with slabs to receive toppings. Assembly consisting of elastomeric winged seals locked into metal edge rails, with flashing for hot-splicing into deck waterproofing. Provide stainless steel retaining caps for edge rails.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Balco; a CSW Industrials Company**]
    b. [**Construction Specialties, Inc.**]
    c. [**EMSEAL; a Sika Company**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**LymTal International, Inc.**]
    f. [**MM Systems Corporation**]
    g. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

    a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
    b. Concentrated Load: [**2000 lb (907 kg)**].
    c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Height: [**To match adjacent topping materials**].
5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Exposed Metal:

a. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

7. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**, Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

D. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.

E. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

F. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

G. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.6 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's stainless steel attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

C. Cast-In Frames: Coordinate and furnish frames to be cast into concrete.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Repair or grout block out as required for continuous frame support, using nonmetallic, shrinkage-resistant grout.
2. Install frames in continuous contact with adjacent surfaces.
    a. Shimming is not permitted.
3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
6. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written

instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer before installing compression seals.

E. Precompressed Foam Parking Deck Expansion Joint Seals:

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

F. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not overpressurize.

G. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

H. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

I. Elastomeric Concrete: Install according to manufacturer's written application instructions.

J. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work, so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

K. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals, and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 07 95 13 00

SECTION 07 95 13 13 - INTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor expansion joint covers.
2. Wall expansion joint covers.
3. Ceiling expansion joint covers.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Floor expansion joint covers.
2. Wall expansion joint covers.
3. Ceiling expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric-seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.
6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to [**UL 2079**][**or**][**ASTM E1966**] by a qualified testing agency.

1. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies to be subjected to hose stream testing.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement:

a. Joint Movement: As indicated on Drawings.

2.3 FLOOR EXPANSION JOINT COVERS

A. Metal-Plate Floor Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Surface mounted.
4. Load Capacity:

a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
b. Concentrated Load: [**300 lb (136 kg)**].
c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Floor Joint Cover : Assembly consisting of center plate that slides over metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]

f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: [**Surface mounted**][**Recessed**][**No bump**].
4. Load Capacity:

   a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
   b. Concentrated Load: [**300 lb (136 kg)**].
   c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Floor Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**Erie Metal Specialties, Inc.**]
   e. [**inpro Corporation**]
   f. [**MM Systems Corporation**]
   g. [**Nystrom, Inc.**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

   a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
   b. Concentrated Load: [**300 lb (136 kg)**].
   c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent**

construction][**1 hour**][**2 hours**].

6. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

D. Hidden-Sightline Floor Joint Cover : Sliding leaf-spring and metal frame assembly designed to accept field-applied finish materials on visible surfaces for minimum frame exposure.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Balco; a CSW Industrials Company**]
    b. [**Construction Specialties, Inc.**]
    c. [**inpro Corporation**]
    d. [**MM Systems Corporation**]
    e. [**Nystrom, Inc.**]
    f. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

    a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
    b. Concentrated Load: [**300 lb (136 kg)**].
    c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

E. Seismic-Pan Floor Joint Cover : Seismic pan assembly with sloped sides allowing extension of unit above floor plane during joint contraction, and equipped with springs to return unit back into alignment during joint expansion. Provide manufacturer's recommended sealant at pan edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**inpro Corporation**]
    e. [**Nystrom, Inc.**]
    f. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

    a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
    b. Concentrated Load: [**300 lb (136 kg)**].
    c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Pan Recess Depth: [**As required to accommodate adjacent flooring**][**1 inch (25 mm)**][**1-1/2 inch (38 mm)**].

F. Elastomeric-Seal Floor Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**EMSEAL; a Sika Company**]
    e. [**Erie Metal Specialties, Inc.**]
    f. [**inpro Corporation**]
    g. [**MM Systems Corporation**]
    h. [**Nystrom, Inc.**]
    i. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: [**Surface mounted**][**Recessed**].
4. Load Capacity:

    a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
    b. Concentrated Load: [**300 lb (136 kg)**].
    c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].

d. Brass: [**Mill**][**Manufacturer's standard**].

7. Seal: Preformed elastomeric membrane or extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Dual-Elastomeric-Seal Floor Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
b. Concentrated Load: [**300 lb (136 kg)**].
c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Center-Plate Design: [**Plain**][**Serrated**][**Recessed to accept field-applied finish materials**].

a. Center-Plate Recess Depth: [**As required to accommodate adjacent flooring**][**1/8 inch (3 mm)**][**3/8 inch (10 mm)**].

7. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

8. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 WALL EXPANSION JOINT COVERS

A. Metal-Plate Wall Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**inpro Corporation**]
    f. [**MM Systems Corporation**]
    g. [**Nystrom, Inc.**]
    h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Wall Joint Cover : Assembly consisting of center plate that slides over gaskets in metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**inpro Corporation**]
    e. [**MM Systems Corporation**]
    f. [**Nystrom, Inc.**]
    g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

4. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Wall Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**inpro Corporation**]
    f. [**MM Systems Corporation**]
    g. [**Nystrom, Inc.**]
    h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

D. Elastomeric-Seal Wall Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]

b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

5. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Dual-Elastomeric-Seal Wall Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Center-Plate Design: [**Plain**][**Recessed to accept gypsum board**][**Recessed to accept wall tile**].
5. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class**

I][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 CEILING EXPANSION JOINT COVERS

A. Metal-Plate Ceiling Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Ceiling Joint Cover : Assembly consisting of center plate that slides over gasket in metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**Nystrom, Inc.**]
f. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Ceiling Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

D. Elastomeric-Seal Ceiling Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

4. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Dual-Elastomeric-Seal Ceiling Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Center-Plate Design: [**Plain**][**Recessed to accept gypsum board**][**Recessed to accept wall tile**].
5. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membranes or extrusions.

    a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Elastomeric-Seal Acoustical Ceiling Joint Cover : Elastomeric-seal assembly designed for use in acoustical ceilings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**inpro Corporation**]
    f. [**Nystrom, Inc.**]
    g. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

5. Seal: Preformed elastomeric membranes or extrusions.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**, Alloy 6061-T6 for sheet and plate.

   1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Brass: ASTM B36/B36M, UNS Alloy C26000 for half hard sheet and coil.

D. Bronze: ASTM B455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.

E. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

F. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

G. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

H. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

2.8 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

   1. Run grain of directional finishes with long dimension of each piece.
   2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.9 COPPER-ALLOY FINISHES

A. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

B. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

2.10 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's [**standard**][**stainless steel**] attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage-resistant grout.

2. Install frames in continuous contact with adjacent surfaces.

   a. Shimming is not permitted.

3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
6. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

F. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

G. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 07 95 13 13

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Task	Specification	Specification Description
07 95 13 13	07 95 13 00	Parking Deck Expansion Joint Cover Assemblies

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SECTION 07 95 13 16 - EXTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior expansion joint covers.

B. Related Requirements:

1. Section 077129 "Manufactured Roof Expansion Joints" for factory-fabricated roof expansion joint cover assemblies.
2. Section 079100 "Preformed Joint Seals" for preformed foam and extruded-silicone joint seals.
3. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for expansion joint cover assemblies subject to vehicular traffic.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Exterior expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each exposed expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.

6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to [**UL 2079**][**ASTM E1966**] by a qualified testing agency.

1. Hose Stream Test: Wall-to-wall and wall-to-soffit assemblies shall be subjected to hose stream testing.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement:

a. Joint Movement: As indicated on Drawings.

2.3 EXTERIOR EXPANSION JOINT COVERS

A. Exterior Metal-Plate Joint Cover : Assembly consisting of sliding metal cover plate in continuous contact with gaskets mounted on metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to soffit**][**Soffit to soffit**].
3. Installation: Surface mounted.
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

B. Exterior Elastomeric-Seal Joint Cover : Assembly consisting of elastomeric seal anchored to surface-mounted frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to soffit**][**Soffit to soffit**].
3. Installation: [**Surface-mounted**][**Recessed**].
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent**

construction][**1 hour**][**2 hours**].

5. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membrane or extrusion.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Preformed Foam Joint Seals: Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of **10 lb/cu. ft. (160 kg/cu. m)** and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Balco; a CSW Industrials Company**]
   b. [**EMSEAL; a Sika Company**]
   c. [**LymTal International, Inc.**]
   d. [**MM Systems Corporation**]
   e. [**Nystrom, Inc.**]
   f. [**Pecora Corporation**]
   g. [**Schul International Company, LLC**]
   h. [**Watson Bowman Acme Corp.**]
   i. [**Willseal LLC, part of Tremco CPG**]

2. Design Criteria:

   a. Nominal Joint Width: [**As indicated on Drawings**].
   b. Minimum Joint Width: [**As indicated on Drawings**].
   c. Maximum Joint Width: [**As indicated on Drawings**].

3. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.4 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**,

Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Brass: ASTM B36/B36M, UNS Alloy C26000 for half hard sheet and coil.

D. Bronze: ASTM B455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.

E. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

F. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

G. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

2.5 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

2.6 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.7 COPPER-ALLOY FINISHES

A. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

B. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

2.8 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's [**standard**][**stainless steel**] attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
4. Install frames in continuous contact with adjacent surfaces.

a. Shimming is not permitted.

5. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Elastomeric Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Preformed Foam Joint Seals: Install in compliance with manufacturer's written instructions. Install with minimum number of end joints.

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

E. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

F. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

G. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

H. Moisture Barrier Drainage: If indicated, provide drainage fitting and connect to drains.

3.4 CONNECTIONS

A. Transition to Roof Expansion Joint Covers: Coordinate installation of exterior wall and soffit expansion joint covers with roof expansion joint covers specified in Section 077129 "Manufactured Roof Expansion Joints."[**Install factory-fabricated units at transition between exterior walls and soffits and roof expansion joint cover assemblies.**]

3.5 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections.

END OF SECTION 07 95 13 16

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Task	Specification	Specification Description
07 95 13 16	07 95 13 13	Interior Expansion Joint Cover Assemblies
07 95 13 16	07 95 13 00	Parking Deck Expansion Joint Cover Assemblies

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SECTION 08 01 52 61 - WOOD WINDOW REPAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes wood window repairs as follows:

1. Repairing wood windows.
2. Repairing wood storm windows.
3. Repairing wood shutters.
4. Repairing wood insect screens.
5. Replacing wood windows with custom-fabricated replicas.
6. Replacing wood storm windows with custom-fabricated replicas.
7. Replacing wood shutters with custom-fabricated replicas.
8. Replacing wood insect screens with custom-fabricated replicas.
9. Replacing weather stripping.
10. Providing new storm windows where none existed previously.
11. Providing new shutters where they no longer exist.
12. Reglazing.
13. Repairing, refinishing, and replacing hardware.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for specific requirements relating to selectively demolishing construction, including window and trim removal.
2. Section 085200 "Wood Windows" for new replacement wood windows or sash not custom fabricated to replicate the originals.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances for wood window repairs.

1. Perform wood window repairs under quantity allowances and only as authorized. Authorized Work includes [**the Work required by Drawings and Specifications and**][**only**] the Work as directed in writing by Architect.
2. Notify Architect [**weekly**]<**Insert time interval**> of extent of the Work performed that is attributable to quantity allowances.
3. Perform the Work that exceeds quantity allowances only as authorized by Change Orders.

B. Provide preconstruction testing as part of testing and inspecting allowance.

C. Replace wood sash in Window No. 1 as part of <**Insert name of allowance**>.

D. Replace shutters at 10 windows as part of <**Insert name of allowance**>.

E. Repair <**Insert item description**> as part of <**Insert name of allowance**>.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting the Work of this Section.

1. Unit prices apply to authorized Work covered by [**quantity allowances**][**estimated quantities**].
2. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.

1.4 DEFINITIONS

A. Design Reference Sample: A sample that represents the Architect's prebid selection of the Work to be matched; it may be existing Work or Work specially produced for the Project.

B. Glazing: Includes glass, glazing points, glazing tapes, glazing sealants, and glazing compounds.

C. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.

D. Window: Includes window frame, sash, trim, and hardware unless otherwise indicated by context.

E. Window Unit: Includes window and [**storm window,**][**exterior shutters,**][**interior shutters,**][**insect screens**] and associated hardware and accessories, unless otherwise indicated by context.

F. Window Component Terminology: Wood window components for repair work include the following classifications:

1. Frame Components: Head, jambs, and sill.
2. Sash Components: Stiles and rails, parting bead, stop, and muntins.
3. Exterior Trim: Exterior casing, brick mold, and cornice or drip cap.
4. Interior Trim: Casing, stool, and apron.
5. <**Insert item**>.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**Project site**][**by web conference**]<**Insert location**>.

1.6 SEQUENCING AND SCHEDULING

A. Perform window repairs in the following sequence, which includes the Work specified in this and other Sections:

1. Label each window frame with permanent opening-identification number in inconspicuous location.
2. Tag existing window sash, trim, storm windows, shutters, and insect screens with opening-identification numbers and remove for on-site or off-site repair. Indicate on tags the locations on window of each component, such as "top sash," "bottom sash," "left shutter," and "right shutter."
3. Remove window, dismantle hardware, and tag hardware with opening-identification numbers.
4. Install temporary protection and security at window openings.
5. In the shop, label each sash, trim, storm window, shutter, and insect screen with permanent opening-identification number in inconspicuous location and remove site-applied tags.
6. Sort units by condition, separating those that need extensive repair.
7. Clean surfaces.

8. General Wood-Repair Sequence:

    a. Remove paint to bare wood.
    b. Rack frames slightly to inject adhesive into mortise and tenon joints; square frames to proper fit before adhesive sets.
    c. If thicker than original glass is required, rout existing muntins to required rebate size.
    d. Repair wood by consolidation, member replacement, partial member replacement, and patching.
    e. Sand, prime, fill, sand again, and prime surfaces again for refinishing.

9. Repair, refinish, and replace hardware if required. Reinstall operating hardware.
10. Install glazing.
11. Remove temporary protection and security at window openings.
12. Reinstall units.
13. Apply finish coats.
14. Install remaining hardware and weather stripping.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, joinery, reinforcing, method of splicing into or attaching to existing wood window unit, accessory items, and finishes.
2. Include field-verified dimensions and provisions for [**sealant joints**][**flashing**][**and**]<**Insert item**> as required for location.
3. <**Insert requirements**>.

C. Samples for Initial Selection: For each type of exposed wood and finish.

1. Identify wood species, cut, and other features.
2. Include Samples of hardware and accessories involving color selection.

D. Samples for Verification: Actual sample of finished product for the following products in manufacturer's standard sizes unless otherwise indicated:

1. Replacement Wood Window Units: **12-inch- (300-mm-)** long, full-size sections with applied finish.
2. Replacement Wood Window Unit Members: **12 inches (300 mm)** long for each wood replacement member.
3. Repaired Wood Window Unit Members: Prepare Samples using existing wood window members removed from site, repaired, and prepared for refinishing.
4. Refinished Wood Window Unit Members: Prepare Samples using existing wood window members removed from site, repaired, and refinished.
5. Hardware: Full-size units with each factory-applied or restored finish.
6. Weather Stripping: **12-inch- (300-mm-)** long sections.
7. Glass: [**Full-size**]<**Insert dimensions**> units of each type and appearance.

1.8 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For wood window repairs.

B. Qualification Statements: For [**wood-window-repair specialist**][**and**][**wood-repair-material manufacturer**].

1.9 QUALITY ASSURANCE

A. Wood-Window-Repair Specialist Qualifications: A qualified wood window specialist, experienced in repairing, refinishing, and replacing wood window units in whole and in part. Experience only in fabricating and installing new wood windows is insufficient experience for repairing wood windows.

1. Title X Requirement: Each firm conducting activities that disturb painted surfaces is required to be a "Lead-Safe Certified Firm" in accordance with 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.

B. Wood-Repair-Material Manufacturer Qualifications: A firm regularly engaged in producing [**wood consolidant**][**and**][**wood-patching compound**] that have been used for similar wood-repair applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.

1.10 MOCKUPS

A. Prepare mockups of window repair to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation. Prepare mockups so they are inconspicuous.

1. Locate mockups [**on existing windows where directed by Architect**][**in locations that enable viewing under same conditions as the completed Work**]<**Insert requirement**>.
2. Wood Window Repairs: Prepare one entire window to serve as mockup to demonstrate samples of each type of repair of wood window members including frame, sash, glazing, and hardware. Demonstrate operable windows will operate as intended after repair.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified wood-window-repair specialist to perform preconstruction testing on wood window units.

1. Provide test specimens representative of proposed materials and existing construction.
2. Test repair products and methods for effectiveness and compliance with specified requirements.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Pack, deliver, and store products in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, broken, or otherwise damaged.

B. Store products inside a well-ventilated area and protect from weather, moisture, soiling, abrasion, extreme temperatures, and humidity, and where environmental conditions comply with manufacturer's requirements.

1.13 FIELD CONDITIONS

A. Weather Limitations: Proceed with wood window repairs only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 HISTORIC WOOD REPAIR QUALITY STANDARD

A. Quality Standard: Comply with applicable requirements in Section 06, "Millwork," in AWMAC/WI's NAAWS for construction, finishes, grades of wood windows, and other requirements, unless otherwise indicated and with the exception of practices cited that delegate Contractor's repair work to specific trades.

2.2 REPLACEMENT WOOD WINDOWS

A. Replacement Wood Windows: Custom-fabricated replicated wood window [**frames**][**and**][**sash**][**and**][**trim**], with operating and latching hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adams Architectural Millwork Co.**]
b. [**Architectural Components, Inc.**]
c. [**Bear Wood Windows, Inc.**]
d. [**Cleary and Son, Inc.**]
e. [**H. Hirschmann LTD**]
f. [**Kingsland Architectural Millwork**]
g. [**Olek Lejbzon & Co.**]
h. [**Parrett Manufacturing, Inc.**]
i. [**Weston Millwork Company**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Adams Architectural Millwork Co.**]
b. [**Architectural Components, Inc.**]
c. [**Bear Wood Windows, Inc.**]
d. [**Cleary and Son, Inc.**]
e. [**H. Hirschmann LTD**]
f. [**Kingsland Architectural Millwork**]
g. [**Olek Lejbzon & Co.**]
h. [**Parrett Manufacturing, Inc.**]

i. [**Weston Millwork Company**]
j. <**Insert manufacturer's name**>

3. Joint Construction: [**Joints matching existing**][**Mortise and tenon joints**][**Doweled joints**]<**Insert requirement**>.
4. Wood, General: Clear fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than **1/32 inch (0.8 mm)** deep by **2 inches (51 mm)** wide.

   a. Species: [**Ponderosa pine**][**Match species of each existing type of wood component or assembly**]<**Insert species**> unless otherwise indicated.

5. Frame Heads and Jambs: [**Match existing species**][**Ponderosa pine**][**Ponderosa pine, eastern white pine, or Idaho white pine**][**Redwood**][**Douglas fir**][**African mahogany**][**Western red cedar**]<**Insert species**>.
6. Exterior Trim: [**Match existing species**][**Match frame heads and jambs**][**All-heart vertical grain redwood**][**African mahogany**]<**Insert species**>.
7. Sills: [**Match existing species**][**White oak**][**All-heart vertical grain redwood**][**African mahogany**][**Western red cedar**]<**Insert species**>.
8. Sash Components: [**Match existing species**][**Ponderosa pine**][**Ponderosa pine, eastern white pine, or Idaho white pine**][**African mahogany**][**Douglas fir**]<**Insert species**>.
9. Interior Trim: [**Match existing species**][**Ponderosa pine**][**Ponderosa pine, eastern white pine, or Idaho white pine**][**African mahogany**]<**Insert species**>.
10. Wood Cut: [**Match cut of existing components**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
11. Wood Window Members: Replicate existing window members.
12. Glazing Stops: Provide replacement glazing stops coordinated with glazing system indicated.
13. Integral Sash Inserts: Manufacturer's standard [**aluminum**][**wood**]-framed [**storm**][**and**][**screen**] sash inserts; Sash-insert frames recessed fully in rebates routed in window frame or sash as required; and secured with turn-button hardware.

    a. Provide insect screen [**for each operable exterior sash or ventilator**][**where indicated on Drawings**][**where indicated in Wood-Window-Repair Schedule**]<**Insert requirement**>.

14. Exposed Hardware: [**Reuse existing hardware unless otherwise indicated; repair and refinish as required**][**Provide replacement hardware**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**].
15. Weather Stripping: Full-perimeter[**and meeting rail**] weather stripping for each operable sash.

2.3 STORM WINDOWS

A. Wood Storm Windows: [**New, custom-fabricated storm window**][**Replacement, custom-fabricated replicated storm window**], tight fitting, with operating and latching hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adams Architectural Millwork Co.**]
   b. [**Allied Window Inc.**]
   c. [**Cleary and Son, Inc.**]
   d. [**Kingsland Architectural Millwork**]

e. [**Weston Millwork Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Adams Architectural Millwork Co.**]
b. [**Allied Window Inc.**]
c. [**Cleary and Son, Inc.**]
d. [**Kingsland Architectural Millwork**]
e. [**Weston Millwork Company**]
f. <**Insert manufacturer's name**>

3. Fabricate storm windows for installation [**on inside of primary window**][**on outside of primary window**][**matching design reference sample**][**matching existing location**][**where indicated on Drawings**][**where indicated in Wood-Window-Repair Schedule**]<**Insert requirement**>.
4. Fabricate storm window frame and sash so as not to be visible from the [**exterior**][**interior**].
5. Make storm windows removable for cleaning and storage.
6. Joint Construction: [**Joints matching existing**][**Mortise and tenon joints**][**Doweled joints**]<**Insert requirement**>.
7. Wood Species: [**Match wood species of existing storm windows**][**Match wood species of exterior trim and sash parts**][**Cedar**]<**Insert requirement**>.
8. Wood Cut: [**Match cut of existing storm windows**][**Match cut of existing exterior wood window trim and sash parts**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
9. Wood Storm-Window Members: [**Match design reference sample**][**Replicate existing wood storm window member**][**As indicated on Drawings**]<**Insert requirement**>.
10. Hardware: [**Provide new hardware**][**Reuse existing hardware unless otherwise indicated; repair and refinish as required**][**Provide replacement hardware**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**].
11. Glazing Material: [**Uncoated clear float glass**][**Plastic glazing**]<**Insert requirement**>.

B. Interior Aluminum Storm Windows: New storm windows fabricated from extruded aluminum to fit inside the wood window frame; finish as indicated; storm window frames concealed from exterior view.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Window Inc.**]
b. [**edi Window Systems, Inc.**]
c. [**Mon-Ray, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allied Window Inc.**]
b. [**edi Window Systems, Inc.**]
c. [**Mon-Ray, Inc.**]
d. <**Insert manufacturer's name**>

3. Aluminum Finish: Manufacturer's standard [**clear anodized**][**light bronze anodized**][**medium**

bronze anodized][**dark bronze anodized**][**anodized color matching design reference sample**][**anodized color matching Architect's sample**][**anodized color as selected by Architect from manufacturer's full range**]<**Insert color**>.

4. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**]<**Insert color**>.
5. Hardware: Provide new hardware.
6. Glazing Material: [**Uncoated clear float glass**][**Plastic glazing**]<**Insert requirement**>.

2.4 SHUTTERS

A. Exterior Wood Shutters: [**New, custom fabricated stile and rail units**][**Replacement, custom fabricated replicated stile and rail units**], tight fitting, with concealed fasteners and operating and latching hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Adams Architectural Millwork Co.**]
    b. [**Beech River Mill**]
    c. [**Custom Shutter Company**]
    d. [**Kestrel Shutters & Doors, Inc.**]
    e. [**Kingsland Architectural Millwork**]
    f. [**Shuttercraft, Inc.**]
    g. [**Timberlane, Inc**]
    h. [**Weston Millwork Company**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Adams Architectural Millwork Co.**]
    b. [**Beech River Mill**]
    c. [**Custom Shutter Company**]
    d. [**Kestrel Shutters & Doors, Inc.**]
    e. [**Kingsland Architectural Millwork**]
    f. [**Shuttercraft, Inc.**]
    g. [**Timberlane, Inc**]
    h. [**Weston Millwork Company**]
    i. <**Insert manufacturer's name**>

3. Operation: [**Fixed to wall**][**Swinging on vertical stile**][**Bahama or Bermuda style, out-swinging from top rail**][**Match design reference sample**][**Match existing**]<**Insert requirement**>.
4. Panel Configuration: [**Louvered**][**Flat**][**Raised**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.
5. Joint Construction: [**Mortise and tenon joints**][**Doweled joints**][**Joints matching design reference sample**][**Joints matching existing**]<**Insert requirement**>.
6. Louver-Slat Construction: [**Routed slats**][**Dadoed slats**][**Pivot pin movable slats with interior control rod**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.

7. Wood Species: [**Match wood species of existing shutters**][**Match wood species of exterior trim and sash parts**][**Cedar**]<**Insert requirement**>.
8. Wood Cut: [**Match cut of existing shutters**][**Match cut of existing exterior wood window trim and sash parts**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
9. Wood Shutter Members: [**Match wood profiles of design reference sample**][**Replicate existing wood shutter members**][**As indicated on Drawings**]<**Insert requirement**>.
10. Wood Preservative: Apply borate preservative treatment to accessible surfaces of exterior wood shutters before finishing. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
11. Hardware: [**Provide new hardware**][**Reuse existing hardware unless otherwise indicated; repair and refinish as required**][**Provide replacement hardware**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**].
12. Drip Cap: [**Aluminum**][**Copper**]<**Insert requirement**> drip cap fitted to window head; finished [**to match window trim**][**white**]<**Insert requirement**>.

B. Interior Wood Shutters: [**New, custom fabricated stile and rail units**][**Replacement, custom fabricated replicated stile and rail units**], tight fitting and removable, and with concealed fasteners and operating and latching hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Beech River Mill**]
    b. [**Custom Shutter Company**]
    c. [**Kestrel Shutters & Doors, Inc.**]
    d. [**Shuttercraft, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Beech River Mill**]
    b. [**Custom Shutter Company**]
    c. [**Kestrel Shutters & Doors, Inc.**]
    d. [**Shuttercraft, Inc.**]
    e. <**Insert manufacturer's name**>

3. Operation: [**Swinging on vertical stile**][**Bifolding leaves, swinging on vertical stile**][**Match design reference sample**][**Match existing**]<**Insert requirement**>.
4. Panel Configuration: [**Louvered**][**Flat**][**Raised**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.

    a. Height: [**Full-height, single units**][**Full-height, double-stacked units**][**Half-height units**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.

5. Joint Construction: [**Mortise and tenon joints**][**Doweled joints**][**Match design reference sample**][**Match existing**]<**Insert requirement**>.
6. Louver-Slat Construction: [**Routed slats**][**Dadoed slats**][**Pivot pin movable slats with interior control rod**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.
7. Wood Species: [**Match wood species of existing interior shutters**][**Match wood species of interior trim and sash parts**][**White oak**]<**Insert requirement**>.

8. Wood Cut: [**Match cut of existing interior shutters**][**Match cut of existing exterior wood window trim and sash parts**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
9. Wood Shutter Members: [**Match wood profiles of design reference sample**][**Replicate existing wood shutter members**][**As indicated on Drawings**]<**Insert requirement**>.
10. Hardware: [**Provide new hardware**][**Reuse existing hardware unless otherwise indicated; repair and refinish as required**][**Provide replacement hardware**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**].

2.5 REPLACEMENT INSECT SCREENS

A. Replacement Wood Insect-Screen Frames: Custom-fabricated, replicated wood insect-screen frame; tight fitting and removable, with a minimum of exposed fasteners and latches.

1. Joint Construction: [**Joints matching existing**][**Mortise and tenon joints**][**Doweled joints**]<**Insert requirement**>.
2. Wood Species: [**Match wood species of existing insect screen**][**Match wood species of window**][**Cedar**]<**Insert requirement**>.
3. Wood Cut: [**Match cut of existing insect screen**][**Match cut of window wood**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
4. Insect-Screen Members: [**Replicate existing insect screen members**][**As indicated on Drawings**]<**Insert requirement**>.

B. Replacement Aluminum Insect-Screen Frames: Extruded aluminum custom fabricated to fit inside interior wood window frame; tight fitting and removable, with a minimum of exposed fasteners and latches; finish as indicated; concealed from exterior view.

1. Mounting: Manufacturer's standard [**magnetic mounting consisting of extruded-aluminum guide at head with magnetic tape at jambs and weather seal at sill**][**mounting consisting of extruded-aluminum guide at sill with screw attachment at head and jambs**]<**Insert description**>.
2. Aluminum Finish: Manufacturer's standard [**clear anodized**][**light bronze anodized**][**medium bronze anodized**][**dark bronze anodized**][**anodized color matching design reference sample**][**anodized color matching Architect's sample**][**anodized color as selected by Architect from manufacturer's full range**]<**Insert color**>.
3. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**]<**Insert color**>.

C. Wickets: Provide [**sliding**][**or**][**hinged**] wickets matching insect-screen frame material and finish; framed and trimmed for a tight fit and durability during use.

D. Copper Wire Fabric: **16-by-16 count per sq. in. (1.3-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter copper wire.

E. Bronze Wire Fabric: **18-by-14 count per sq. in. (1.1-by-1.5-mm)** mesh of [**0.009-inch- (0.23-mm-)**][**0.011-inch- (0.28-mm-)**] diameter bronze wire with a clear varnish finish.

F. Aluminum Wire Fabric: **18-by-16 count per sq. in. (1.1-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire; [**natural bright**][**charcoal gray**][**black**] finish.

2.6 WOOD-REPAIR MATERIALS

A. Source Limitations: Obtain wood consolidant and wood-patching compound from single source from single manufacturer.

B. Wood Consolidant: Ready-to-use product designed to penetrate, consolidate, and strengthen soft fibers of wood materials that have deteriorated due to weathering and decay and designed specifically to enhance the bond of wood-patching compound to existing wood.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Abatron, Inc**]
b. [**ConServ Epoxy LLC**]
c. [**Gougeon Brothers, Inc.**]
d. [**Protective Coating Company**]
e. [**System Three Resins, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Abatron, Inc**]
b. [**ConServ Epoxy LLC**]
c. [**Gougeon Brothers, Inc.**]
d. [**Protective Coating Company**]
e. [**System Three Resins, Inc.**]
f. <**Insert manufacturer's name**>

C. Wood-Patching Compound: Two-part epoxy-resin wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound designed for filling voids in damaged wood materials that have deteriorated due to weathering and decay. Compound capable of filling deep holes and spreading to feather edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Abatron, Inc**]
b. [**Advanced Repair Technology, Inc.**]
c. [**ConServ Epoxy LLC**]
d. [**Gougeon Brothers, Inc.**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**Protective Coating Company**]
g. [**System Three Resins, Inc.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Abatron, Inc**]
b. [**Advanced Repair Technology, Inc.**]
c. [**ConServ Epoxy LLC**]
d. [**Gougeon Brothers, Inc.**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**Protective Coating Company**]
g. [**System Three Resins, Inc.**]
h. <**Insert manufacturer's name**>

2.7 GLAZING MATERIALS

A. Glass:

1. See Section 088000 "Glazing."
2. [**Uncoated clear float-glass**][**Clear insulating-glass**][**Low-E clear insulating-glass**][**Glass Type GL-xx**]<**Insert description**> units according to Section 088000 "Glazing."
3. <**Insert requirements**>.

B. Plastic Glazing: [**Uncoated monolithic acrylic**][**Coated monolithic acrylic**][**Uncoated monolithic polycarbonate**][**Abrasion- and UV-resistant monolithic polycarbonate**][**UV-resistant monolithic polycarbonate**]<**Insert description**> sheet according to Section 088400 "Plastic Glazing."

C. Glazing Systems:

1. Traditional Glazing Products: Glazing points and oil-based glazing putty or latex glazing compound. Tint to required color in accordance with manufacturer's written instructions.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) DAP Products Inc.
        2) Sarco Putty Company, Inc.
        3) <**Insert manufacturer's name**>.

    b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

2. Polyurethane Glazing Products: Glazing points and single-component polyurethane glazing compound; ASTM C920, Type S, Grade NS, Class 25, Use G; struck uniformly to match taper of existing glazing system (removed); colored as required to match painted sash.
3. Silicone Glazing Products: Glazing securement and silicone glazing sealant according to Section 088000 "Glazing"; struck uniformly to match taper of existing glazing system (removed); colored as required to match painted sash.
4. Primers and Cleaners for Glazing: As recommended in writing by glazing material manufacturer.

2.8 HARDWARE

A. General:

1. Window Hardware: Provide complete sets of window hardware consisting of sash balances,

hinges, pulls, latches, and accessories indicated for each window or required for proper operation. Sets to include replacement hardware to complement repaired and refinished, existing hardware, where required, unless otherwise indicated. Window hardware to smoothly operate, tightly close, and securely lock wood windows and be sized to accommodate sash or ventilator weight and dimensions.

2. Other Hardware: Provide complete sets of hardware for each type of [**storm window**][**shutter**][**and**][**insect screen**] consisting of hinges, pulls, latches, and accessories indicated or required for proper operation. Sets to include replacement hardware to complement repaired and refinished, existing hardware, where required, unless otherwise indicated. Hardware to smoothly operate, tightly close, and secure units appropriately for unit weight and dimensions.

B. New Hardware: Provide hardware for [**storm windows**][**and**][**shutters**] as follows:

1. Wood Storm Windows: [**Match design reference sample**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**][**As required to secure storm window to window frames**]<**Insert requirement**>
2. Interior Aluminum Storm Windows: [**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**][**As required to secure storm window to window frames**][**Magnetic mounting**][**Extruded-aluminum track slides at head and sill**]<**Insert requirement**>.
3. Exterior Wood Shutters: [**Match design reference sample**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**][**As required to secure shutter to window frames and latch tightly**][**As required to secure shutter to window frames, with pintle hinges to allow removability, and to latch tightly**][**As required to secure shutter to wall**]<**Insert requirement**>.
4. Interior Wood Shutters: [**Match design reference sample**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**][**As required to secure shutter to window frames and latch tightly**]<**Insert requirement**>.

C. Replacement Hardware: Replace existing damaged or missing hardware with new [**custom hardware to replicate existing hardware**][**hardware matching type and appearance of existing hardware**] manufactured by one of the following:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Resource Center (The)**]
    b. [**Ball and Ball, LLC**]
    c. [**Blaine Window Hardware Inc.**]
    d. [**Bronze Craft Corporation (The)**]
    e. [**Phelps Company**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Architectural Resource Center (The)**]
    b. [**Ball and Ball, LLC**]
    c. [**Blaine Window Hardware Inc.**]
    d. [**Bronze Craft Corporation (The)**]
    e. [**Phelps Company**]
    f. <**Insert manufacturer's name**>

3. Replacement Hardware Types: Duplicate existing exposed hardware of the following types:

    a. Projected window hinge.
    b. Window lock.
    c. Window latch.
    d. Handle.
    e. Pole ring.
    f. Shutter hinges.
    g. Shutter dogs (tiebacks).
    h. Shutter pull rings.
    i. Shutter slide bolts.
    j. Shutter catches.
    k. <**Insert hardware type**>.

4. Weight and Pulley Sash-Balance: Concealed weight and pulley balance system including steel or cast iron weights, cast-bronze pulleys, [**synthetic sash cord**][**bronze sash chain**][**or**][**stainless-steel sash chain**]<**Insert requirement**>; size and capacity to hold sash stationary at any open position.
5. Spring Sash-Balance: Concealed [**tape-spring**][**spiral-tube**][**spring-loaded, block-and-tackle**]<**Insert description**> type; size and capacity to hold sash stationary at any open position.

D. Hardware Materials: [**Solid bronze of alloy indicated**][**Cast or wrought aluminum**][**Nonmagnetic stainless steel**]<**Insert material**> unless otherwise indicated.

E. Hardware Finishes: Comply with ANSI/BHMA A156.18 for base material and finish requirements indicated by the following:

1. ANSI/BHMA 605: Bright brass, clear-coated; brass base metal.
2. ANSI/BHMA 606: Satin brass, clear-coated; brass base metal.
3. ANSI/BHMA 611: Bright bronze, clear-coated; bronze base metal.
4. ANSI/BHMA 612: Satin bronze, clear-coated; bronze base metal.
5. ANSI/BHMA 613: Dark-oxidized satin bronze, oil-rubbed; bronze base metal.
6. ANSI/BHMA 624: Dark-oxidized statuary bronze, clear-coated; bronze base metal.
7. ANSI/BHMA 628: Satin aluminum, clear-anodized; aluminum base metal.
8. ANSI/BHMA 630: Satin stainless steel; stainless-steel base metal.
9. ANSI/BHMA 689: Aluminum painted; over any base metal.
10. <**Insert finish or special custom finish**>.

2.9 REPLACEMENT WEATHER STRIPPING

A. Replacement Compression-Type Weather Stripping: Compressible weather stripping designed for permanently resilient sealing under bumper or wiper action; completely concealed when window is closed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**National Guard Products, Inc**]
    b. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
    c. [**Reese Enterprises, Inc**]
    d. [**Zero International; Allegion plc**]

e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**National Guard Products, Inc**]
b. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
c. [**Reese Enterprises, Inc**]
d. [**Zero International; Allegion plc**]
e. <**Insert manufacturer's name**>

3. Weather-Stripping Material: Match existing materials and profiles as much as possible unless otherwise indicated.

a. Cellular Elastomeric Gaskets: Preformed; complying with ASTM C509.
b. Dense Elastomeric Gaskets: Preformed; complying with ASTM C864.

B. Replacement Sliding-Type Weather Stripping: Woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**National Guard Products, Inc**]
b. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
c. [**Reese Enterprises, Inc**]
d. [**Zero International; Allegion plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**National Guard Products, Inc**]
b. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
c. [**Reese Enterprises, Inc**]
d. [**Zero International; Allegion plc**]
e. <**Insert manufacturer's name**>

3. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material.

C. Replacement Metal Weather Stripping: [**Bronze**][**Zinc**]<**Insert metal**> weather stripping; designed either as one piece to seal by sliding into a groove in the sash or as two pieces that interlock; and completely concealed when window is closed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reese Enterprises, Inc**]
b. [**Zero International; Allegion plc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Reese Enterprises, Inc**]
b. [**Zero International; Allegion plc**]
c. <**Insert manufacturer's name**>

2.10 MISCELLANEOUS MATERIALS

A. Borate Preservative Treatment: Inorganic, borate-based solution, with disodium octaborate tetrahydrate as the primary ingredient; manufactured for preserving weathered and decayed wood from further damage by decay fungi and wood-boring insects; containing no boric acid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Nisus Corporation**]
b. [**System Three Resins, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Nisus Corporation**]
b. [**System Three Resins, Inc.**]
c. <**Insert manufacturer's name**>

B. Cleaning Materials:

1. Detergent Solution: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent that contains no ammonia, **5 quarts (5 L)** of 5 percent sodium hypochlorite bleach, and **15 quarts (15 L)** of warm water for each **5 gal. (20 L)** of solution required.
2. Mildewcide: Commercial, proprietary mildewcide or a solution prepared by mixing **1/3 cup (80 mL)** of household detergent that contains no ammonia, **1 quart (1 L)** of 5 percent sodium hypochlorite bleach, and **3 quarts (3 L)** of warm water.

C. Adhesives: Wood adhesives with minimum 15- to 45-minute cure at **70 deg F (21 deg C)**, in gunnable and liquid formulations as recommended in writing by adhesive manufacturer for each type of repair and exposure condition.

D. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.

1. Match existing fasteners in material and type of fastener unless otherwise indicated.
2. Use concealed fasteners for interconnecting wood components.
3. Use concealed fasteners for attaching items to other work unless exposed fasteners are

[**unavoidable**][**or**][**the existing fastening method**].

4. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.
5. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
6. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.

E. Anchors, Clips, and Accessories: Fabricate anchors, clips, and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel complying with requirements in ASTM B633 for SC 3 (Severe) service condition.

2.11 WOOD WINDOW UNIT FINISHES

A. Unfinished Replacement Units: Provide exposed [**exterior**][**and**][**interior**] wood surfaces of replacement units unfinished; smooth, filled, and suitably prepared for on-site priming and finishing.

B. Factory-Primed Replacement Units: [**Manufacturer's standard**]<**Insert requirement**> factory-prime coat on exposed [**exterior**][**and**][**interior**] wood surfaces; compatible with indicated finish coating.

C. Factory-Finished Units: [**Alkyd**][**Latex**]<**Insert system type**> finish system consisting of [**primer and two finish coats**]<**Insert requirement**> on exposed [**exterior**][**and**][**interior**] wood surfaces.

1. Finish Coats: [**Manufacturer's standard.**][**Match intermediate coat and topcoat products used for adjacent, repaired wood windows.**]<**Insert requirement.**>
2. Color and Gloss: Match [**Munsell Color 10 G 8/2**][**Plochere Color System #8da399**][**colors indicated on Drawings**]<**Insert color(s) or requirement**>.

PART 3 - EXECUTION

3.1 WOOD-WINDOW-REPAIR SPECIALIST

A. Wood-Window-Repair Specialist Firms: Subject to compliance with requirements, [**provide wood window repairs by one of the following**][**firms that may provide wood window repairs include, but are not limited to, the following**]:

1. <**Insert, in separate subparagraphs, names of wood-window-repair specialist firms**>.

3.2 WOOD WINDOW UNIT REPAIRS, GENERAL

A. Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from the window interior at [**5 ft. (1.5 m)**][**10 ft. (3 m)**]<**Insert distance**> away and from the window exterior at [**20 ft. (6 m)**][**50 ft. (15 m)**]<**Insert distance**> away.

B. General: In repairing wood window units, disturb them as minimally as possible and as follows:

1. Stabilize and repair wood window units to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
2. Repair items in place where possible.
3. Refinish wood window units in accordance with Section 090190.52 "Maintenance Repainting" unless otherwise indicated.
4. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use gentle mechanical

methods, such as scraping and natural-fiber bristle brushing, that will not abrade wood substrate, reducing clarity of detail.

C. Identify removed window units with numbering system corresponding to window locations to ensure reinstallation in same location. Key window units to Drawings indicating location of each removed unit. Permanently label units in a location that will be concealed after reinstallation.

3.3 EXAMINATION

A. Examine areas, and conditions, with wood-window-repair specialist present, for compliance with requirements for environmental conditions, and other conditions affecting performance of the Work.

1. If existing wood window units cannot be prepared to an acceptable condition for repair, notify Architect in writing.
2. Notify Architect of undocumented detrimental conditions, including rotted wood and other deteriorated items.

B. Begin wood window unit repair work only after unsatisfactory conditions have been corrected.

3.4 PREPARATION

A. Protect adjacent materials from damage by performing wood window unit repairs.

B. Install temporary protective measures to protect wood window unit work that is indicated to be completed later.

C. Clean wood window units of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.

D. Condition replacement wood members and replacement units to prevailing conditions at installation areas before installing.

E. Remove coatings and apply borate preservative treatment before repair. Remove coatings in accordance with Section 090190.52 "Maintenance Repainting" unless otherwise indicated.

F. Protection of Openings: Where sash or windows are indicated for removal, cover resultant openings with temporary enclosures so that openings are weathertight during repair period.

3.5 WOOD WINDOW UNIT REPAIR

A. Repair and Refinish Existing Hardware: Dismantle window hardware; strip paint, repair, and refinish it to match finish samples; and lubricate moving parts just enough to function smoothly.

B. Repair Wood Window Units: Replicate existing.

1. Repair wood window units by consolidating, patching, splicing, or otherwise reinforcing wood with new wood matching existing wood or with salvaged, sound, original wood.
2. Sash Balance: Repair sash balances to function according to type as specified in "Hardware" Article" above. Provide missing sash balances.

3.6 WOOD WINDOW UNIT PATCH-TYPE REPAIR

A. General: Patch wood members that exhibit depressions, holes, or similar voids and that have limited amounts of rotted or decayed wood.

1. Remove [**sash**][**storm windows**][**and**][**screens**] from windows before performing patch-type repairs at meeting or sliding surfaces unless otherwise indicated. Reglaze units before reinstallation.
2. Verify that surfaces are sufficiently clean and free of paint residue before patching.
3. Remove rotted or decayed wood down to sound wood.

B. Apply borate preservative treatment to accessible surfaces after removing rotted or decayed wood and before applying wood consolidant or patching compound. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom. Allow treatment to dry.

C. Apply wood-patching compound to fill depressions, nicks, cracks, and other voids created by removed or missing wood.

1. Prime patch area with application of wood consolidant or manufacturer's recommended primer.
2. Mix only as much patching compound as can be applied in accordance with manufacturer's written instructions.
3. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.
4. Sand patch surface smooth and flush with adjacent wood, without voids in patch material, and matching contour of wood member.
5. Clean spilled compound from adjacent materials immediately.

3.7 WOOD WINDOW UNIT, MEMBER-REPLACEMENT REPAIR

A. General: Replace parts of or entire wood window unit members at locations [**indicated on Drawings**][**indicated in the Wood-Window-Repair Schedule**][**and**][**where damage is too extensive to patch**]<**Insert requirement**>.

1. Remove [**sash**][**storm windows**][**and**][**shutters**] from windows before performing member-replacement repairs unless otherwise indicated.
2. Verify that surfaces are sufficiently clean and free of paint residue before repair.
3. Remove broken, rotted, and decayed wood down to sound wood.
4. Custom fabricate new wood part or member to replace missing wood part or member; either replace entire wood member or splice new wood part into existing member.
5. Secure new wood part or member using finger joints, multiple dowels, or splines with adhesive and nailing to ensure maximum structural integrity at each splice. Use only concealed fasteners. Fill nail holes and patch surface to match surrounding sound wood.

B. Apply borate preservative treatment to accessible surfaces after replacements are made. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.

C. Repair remaining depressions, holes, or similar voids with patch-type repairs.

D. Clean spilled materials from adjacent surfaces immediately.

E. Glazing: Reglaze units before reinstallation.

1. Mill new and rout existing glazed members to accommodate new glass thickness.
2. Provide replacement glazing stops coordinated with glazing system indicated.
3. Provide glazing stops to match contour of sash frames.

F. Reinstall units removed for repair into original openings.

G. Weather Stripping: Replace nonfunctioning and install missing weather stripping to ensure full-perimeter[**and meeting rail**] weather stripping for each operable sash.

3.8 WOOD WINDOW UNIT REPLACEMENT

A. General: Replace existing wood [**window frame**][**sash**][**exterior trim**][**interior trim**][**storm window**][**exterior shutter**][**interior shutter**][**and**][**insect screen**] units with custom-fabricated, replicated units at locations [**indicated on Drawings**][**indicated in the Wood-Window-Repair Schedule**][**and**][**where damage is too extensive to repair**]<**Insert requirement**>.

B. Use surviving prototypes to create patterns for duplicate replacements.

C. Apply borate preservative treatment to accessible surfaces before finishing. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.

D. Mill glazed members to accommodate glass thickness. Glaze units before installation.

3.9 REGLAZING

A. Comply with combined written instructions of manufacturers of glass, glazing systems, and glazing materials, unless more stringent requirements are indicated.

B. Remove cracked and damaged glass and glazing materials from openings and prepare surfaces for reglazing.

C. Remove existing glass and glazing where indicated [**on Drawings**][**in the Wood-Window-Repair Schedule**], and prepare surfaces for reglazing.

D. Remove glass and glazing from openings and prepare surfaces for reglazing.

E. Size glass as required by Project conditions to provide necessary bite on glass, minimum edge and face clearances, with reasonable tolerances.

F. Apply primers to joint surfaces where required for adhesion of glazing system, as determined by preconstruction testing.

G. Install setting bead, side beads, and back bead against stop in glazing rabbets before setting glass, in accordance with glazing-system manufacturer's instructions.

H. Install glass with proper orientation so that coatings, if any, face exterior or interior as required.

I. Install glazing system.[**Install silicone glazing products as specified in Section 088000 "Glazing."**]

J. Disposal of Removed Glass: [**Remove from Owner's property and legally dispose of it**][**Protect unbroken lites and deliver as salvage to Owner for storage where directed**]<**Insert requirement**> unless otherwise indicated.

3.10 INSTALLATION OF REPLACEMENT WOOD WINDOWS

A. Install units, hardware, weather stripping, accessories, and other components[**as indicated on Drawings**].

B. Install units level, plumb, square, true to line, without distortion or impeding movement; anchored securely in place to structural support; and in proper relation to wall flashing, trim, and other adjacent construction.

C. Set sill members in bed of sealant for weathertight construction unless otherwise indicated.

D. Install window units with new anchors into existing openings.

E. Weather Stripping: Install full-perimeter[**and meeting rail**] weather stripping for each operable sash.

F. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

G. Disposal of Removed Units: [**Remove from Owner's property and legally dispose of them**][**Deliver as salvage to Owner for storage where directed**]<**Insert requirement**>.

3.11 INSTALLATION OF STORM WINDOWS

A. Install wood storm windows at each window jamb[**indicated**].

B. Install interior aluminum storm windows at each window[**indicated**].

C. Install units by mounting to window frames[**as indicated on Drawings and**] in accordance with manufacturer's written instructions.

D. Disposal of Removed Units: [**Remove from Owner's property and legally dispose of them**][**Deliver as salvage to Owner for storage where directed**]<**Insert requirement**>.

3.12 INSTALLATION OF SHUTTERS

A. Install wood shutters at each window jamb[**indicated**].

B. Install units by mounting[**as indicated on Drawings and**] in accordance with manufacturer's written instructions.

C. Disposal of Removed Units: [**Remove from Owner's property and legally dispose of them**][**Deliver as salvage to Owner for storage where directed**]<**Insert requirement**>.

3.13 INSTALLATION OF REPLACEMENT INSECT SCREENS

A. Install [**wood**][**aluminum**] insect-screen frames [**for each operable exterior sash or ventilator**][**where indicated**]<**Insert requirement**>.

1. Locate insect-screen frames on [**inside**][**outside**] of window unless otherwise indicated.
2. Install insect-screen frames by mounting to window or sash frame[**as indicated on Drawings and**] in accordance with manufacturer's written instructions.

B. Install insect screening to be smooth, flat, and uniformly taut.

C. Disposal of Removed Units: [**Remove from Owner's property and legally dispose of them**][**Deliver as salvage to Owner for storage where directed**]<**Insert requirement**>.

3.14 INSTALLATION OF REPLACEMENT WEATHER STRIPPING

A. Install weather stripping for tight seal of joints as determined by preconstruction testing and demonstrated in mockup.

3.15 ADJUSTING

A. Adjust existing and replacement operating sash, screens, hardware, weather stripping, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

3.16 CLEANING AND PROTECTION

A. Protect window surfaces from contact with contaminating substances resulting from construction operations. Monitor window surfaces adjacent to and below exterior concrete and masonry during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact window surfaces, remove contaminants immediately.

B. Clean exposed surfaces immediately after repairing wood windows. Avoid damage to coatings and finishes. Remove excess sealants, glazing and patching materials, dirt, and other substances.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction.

3.17 WOOD-WINDOW-REPAIR SCHEDULE

A. Wood Window Repair: [**WW-#**]<**Insert drawing designation**>

1. Description: [**Single-hung**][**Double-hung**][**Triple-hung**][**Casement**][**Fixed**]<**Insert window description**> window.
2. General: Repair existing wood windows using indicated treatments. Repair sash, storm windows, and shutters [**on-site**][**or**][**off-site**]<**Insert requirement**>.
3. Removal of Existing Paint and Refinishing: See Section 090190.52 "Maintenance Repainting" for paint removal, surface preparation for refinishing, and refinishing wood windows.
4. Window Frame Repair: [**Wood consolidant**][**patch-type repairs**][**whole or partial member-replacement repairs**][**and**][**re-anchor frame as indicated on Drawings**]<**Insert repair description**>.
5. Window Frame Member Repair: Repair [**head**][**jambs**][**sill**] with [**wood consolidant**][**patch-type repairs**][**and**][**whole or partial member-replacement repairs**]. [**Re-anchor**][**and**][**realign**] the [**head**][**jambs**][**sill**]. <**Insert repair description**>.
6. Window Sash Repair: [**Wood consolidant**][**patch-type repairs with sash removed from opening**][**patch-type repairs in place**][**and**][**whole or partial member-replacement repairs**]<**Insert repair description**>.
7. Window Sash Member Repair: Repair [**stile**][**rails**][**parting bead**][**stop**][**and**][**muntins**]<**Insert component**> with [**wood consolidant**][**patch-type repairs**][**and**][**whole or partial member-**

replacement repairs]. Realign [**stiles**][**rails**][**parting bead**][**and**][**stops**]<**Insert component**>.

8. Window Sash Replacement: Remove existing units for replacement with custom-fabricated, replicated units.
9. Hardware: [**Sash balance**][**Projected window hinge**][**Window lock**][**Window latch**][**Handle**][**Pole ring**]<**Insert hardware type**>.
10. <**Insert requirements**>.

B. Wood Window Replacement: [**WW-#**]<**Insert drawing designation**>

1. Description: [**Single-hung**][**Double-hung**][**Triple-hung**][**Casement**][**Fixed**]<**Insert window description**> window.
2. General: Remove wood window completely, including window frame and sash, and replace with custom-fabricated, replicated wood windows.
3. Wood Exterior Shutters: Custom-fabricated, [**new**][**replicated**] units specified in this Section.
4. Wood Interior Shutters: Custom-fabricated, [**new**][**replicated**] units specified in this Section.
5. Hardware: [**Sash balance**][**Projected window hinge**][**Window lock**][**Window latch**][**Handle**][**Pole ring**]<**Insert hardware type**>.
6. <**Insert requirements**>.

END OF SECTION 08 01 52 61

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SECTION 08 01 52 61A - WOOD WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Unclad wood windows.
2. Aluminum-clad wood windows.
3. Vinyl-clad wood windows.
4. Fiberglass-clad wood windows.

1.2 DEFINITIONS

A. Combination Assemblies: Assemblies formed by a combination of two or more separate fenestration products whose frames are mulled together using a combination mullion or reinforcing mullion.

B. Combination Mullions: Horizontal or vertical members formed by joining two or more individual fenestration units together without a mullion stiffener.

C. Reinforcing Mullions: Horizontal or vertical members with an added continuous mullion stiffener and joining two or more individual fenestration units along the sides of the mullion stiffener.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate interrelationship of wood windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, window rough openings, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: For units with factory-applied finishes, manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

1. Include Samples of hardware and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish:

1. Exposed Finishes: [**Manufacturers' standard size**][**2 by 4 inches (50 by 100 mm)**].
2. Exposed Hardware: Full-size units.

E. Product Schedule: For wood windows. Use same designations indicated on Drawings.

F. Delegated Design Submittals: For [**reinforcing mullions**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

G. Sustainable Design Submittals:

1. Chain-of-Custody Qualification Data: For manufacturer and vendor.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each wood window, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports: For wood windows.

C. Qualification Statements: For manufacturer and Installer.

D. Delegated Design Engineer Qualifications: For [**reinforcing mullions**].

E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating hinged wood-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: [**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**].

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

D. Testing Agency Qualifications: WDMA-accredited testing agency for testing indicated.

E. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood windows to Project site in original, unopened packages and store them in accordance with manufacturer's written instructions. Protect wood windows against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle wood windows in a manner that prevents damage before, during, and after installation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install wood windows outside of limits recommended in writing by manufacturer.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace wood windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures, including excessive deflection, water leakage, and air infiltration.
c. Faulty operation of movable sash and hardware.
d. Deterioration of materials and finishes beyond normal weathering.
e. Failure of insulating glass.

2. Warranty Period:

a. Window: [**Two**][**Five**][**10**] years from date of Substantial Completion.
b. Glazing Units: [**Five**][**10**] years from date of Substantial Completion.
c. Hardware: [**Three**] years from date of Substantial Completion.
d. Aluminum-Cladding Finish: [**10**][**20**] years from date of Substantial Completion.
e. Vinyl Cladding: Lifetime warranty.
f. Fiberglass Cladding: [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain wood windows from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality

Requirements," to design [**reinforcing mullions**].

B. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: WDMA certified with label attached to each window.

C. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**R**][**LC**][**CW**][**As indicated on Drawings**].
2. Minimum Performance Grade: [**15**][**20**][**25**][**30**][**35**][**40**][**45**][**50**][**As indicated on Drawings**].
3. Mulled Window Systems: Evaluate and rate combination assemblies as single systems as determined by AAMA 450 in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 requirements.

D. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor): As determined in accordance with NFRC 100:

a. Fixed Windows: Not more than [**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.34 Btu/sq. ft. x h x deg F (1.93 W/sq. m x K)**][**0.29 Btu/sq. ft. x h x deg F (1.65 W/sq. m x K)**][**0.26 Btu/sq. ft. x h x deg F (1.48 W/sq. m x K)**].

b. Operable Windows: Not more than [**0.62 Btu/sq. ft. x h x deg F (3.52 W/sq. m x K)**][**0.60 Btu/sq. t. x h x deg F (3.41 W/sq. m x K)**][**0.54 Btu/sq. ft. x h x deg F (3.07 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.82 W/sq. m x K)**].

2. Solar Heat-Gain Coefficient (SHGC): As determined in accordance with NFRC 200:

a. Fixed Windows: Not more than [**0.23**][**0.25**][**0.36**][**0.38**][**0.40**].
b. Operable Windows: Not more than [**0.21**][**0.23**][**0.33**][**0.34**][**0.36**] as determined in accordance with NFRC 200.

3. Condensation-Resistance Factor (CRF): Provide windows tested for thermal performance in accordance with AAMA 1503, showing a CRF of [**45**][**52**].

E. Outdoor-Indoor Transmission Class (OITC): Rated for not less than [**22**][**26**][**30**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

F. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located more than [**30 ft. (9.1 m)**] above grade.

2.3 WOOD WINDOWS, GENERAL

A. Provide manufacturer's standard wood window assemblies consisting of frames, sashes, glass, hardware, fasteners, and all components and accessories as required for a complete installation.

2.4 UNCLAD WOOD WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**JELD-WEN, Inc.**]
2. [**Kolbe Windows & Doors**]
3. [**Marvin**]
4. [**Pella Corporation**]
5. [**Ply-Gem**]
6. [**Sierra Pacific Windows; Sierra Pacific Industries**]
7. [**Weather Shield Mfg., Inc**]

B. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.
2. Awning: Project out.
3. Hopper: Project in.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

C. Exterior Surfaces: [**Manufacturer's standard paint-grade wood species**][**Pine**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Manufacturer's standard factory-applied primer**][**Manufacturer's standard factory-applied color-coated finish**][**Unfinished**].

    a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Mahogany**][**Fir**][**Alder**][**Oak**][**Cherry**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied primer for field painting**][**Manufacturer's standard factory-applied color-coated finish**][**Manufacturer's standard factory-applied stain and transparent finish**].

    a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 ALUMINUM-CLAD WOOD WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**JELD-WEN, Inc.**]
3. [**Kolbe Windows & Doors**]
4. [**Marvin**]
5. [**Pella Corporation**]
6. [**Ply-Gem**]
7. [**Sierra Pacific Windows; Sierra Pacific Industries**]
8. [**Weather Shield Mfg., Inc**]

B. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.
2. Awning: Project out.
3. Hopper: Project in.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

C. Exterior Surfaces: [**Manufacturer's standard aluminum cladding**].

1. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry-film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and curing finish.

    a. Color and Gloss: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Color and Gloss: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Fir**][**Alder**][**Oak**][**Cherry**][**Mahogany**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied primer for field painting**][**Manufacturer's standard factory-applied color-coated finish**][**Manufacturer's standard factory-applied stain and transparent finish**].

    a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 VINYL-CLAD WOOD WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**Sierra Pacific Windows; Sierra Pacific Industries**]

B. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.
2. Awning: Project out.
3. Hopper: Project in.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

C. Exterior Surfaces: Manufacturer's standard vinyl-cladding.

1. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Oak**][**Maple**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied color-coated white finish**].

2.7 FIBERGLASS-CLAD WOOD WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**Kolbe Windows & Doors**]

B. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.
2. Awning: Project out.
3. Hopper: Project in.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

C. Exterior Surfaces: Manufacturer's standard fiberglass-clad frame.

1. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Oak**][**Maple**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied color-coated white finish**].

2.8 WINDOW COMPONENTS

A. Frames and Sashes: Fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln

dried to a moisture content of not more than 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than **1/32 inch (0.8 mm)** deep by **2 inches (51 mm)** wide; water-repellent preservative treated.

2.9 GLASS AND GLAZING

A. True Divided Lites: Fabricate glazing with true muntins resulting in individually glazed lites; provide muntin configuration and profile indicated on Drawings.

B. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

1. Kind: Fully tempered [**where indicated on Drawings**].

C. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172 with two plies of float glass.

1. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
2. Inner Ply: Clear.
3. Interlayer: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].
4. Outer Ply: [**Clear**][**Gray**][**Bronze**][**Green**].
5. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

D. Insulating-Glass Units: ASTM E2190.

1. Glass: ASTM C1036, Type 1, Class 1, q3.

a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
b. Kind: Fully tempered [**where indicated on Drawings**].

2. Lites: [**Two**][**Three**].
3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

E. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190 with two lites and complying with impact-resistance requirements in "Performance Requirements" Article.

1. Exterior Lite: ASTM C1036, Type 1, Class 1, q3.

a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
b. Kind: [**Heat strengthened**][**Fully tempered**].

2. Interior Lite: ASTM C1172 clear laminated glass with two plies of float glass.

a. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
b. Interlayer Thickness: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].

3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

F. Glazing System: [**Manufacturer's standard factory-glazing system that produces weathertight seal**].

1. Dual-Glazing System:

a. Interior Lite: [**Glass**].
b. Exterior Lite: [**Glass**][**Insulating-glass unit**].

2.10 HARDWARE

A. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Projected Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

a. Type and Style: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range of types and styles**], as directed by the Owner.

2. Hinges: [**Manufacturer's standard type for sash weight and size indicated**][**Stainless steel hinges with stainless steel-reinforced, sliding nylon shoes**].
3. Single-Handle Locking System: Operates positive-acting arms that pull sash into locked position. Provide one arm on sashes up to **29 inches (735 mm)** tall and two arms on taller sashes.
4. Limit Devices: [**Concealed friction adjustor, adjustable stay bar**][**Concealed support arms with adjustable, limited, hold-open**] limit devices designed to restrict sash opening.

a. Limit clear opening to [**4 inches (100 mm)**] for ventilation; with custodial key release.

5. Operator Stud Cover: Matching operator handle finish. Provide in locations where operator handle is removed for controlled access.
6. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than **60 inches (1500 mm)** above floor; one pole operator and pole hanger per room that has operable windows more than **72 inches (1800 mm)** above floor.

C. Hung Window Hardware:

1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide custodial locks.**]
3. Tilt Hardware: Releasing tilt latch allows sash to pivot about horizontal axis to facilitate cleaning exterior surfaces from the interior.

D. Horizontal-Sliding Window Hardware:

1. Sill Cap/Track: [**Extruded-aluminum track with natural anodized finish**][**Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color**][**Manufacturer's standard**] of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide custodial locks.**]
3. Roller Assemblies: Low-friction design.

E. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

F. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Avoid exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

G. Mullions: Provide manufacturer's standard combination and reinforcing mullions and cover plates matching window units, complete with anchors for support to structure. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide reinforcing mullions and cover plates capable of withstanding design wind loads of window units.

2.11 ACCESSORIES

A. Dividers (False Muntins): Provide divider grilles in designs indicated for each sash lite.

1. Quantity and Type: [**One per sash, removable from exposed surface of interior lite**][**Two per sash, removable from exposed surfaces of interior and permanently located at exterior lite**][**Two per sash, permanently located at exterior and interior lites**][**One permanently located between insulating-glass lites**][**Three per sash, two permanently located at exterior and interior lites and one permanently located between insulating-glass lites**].
2. Material: [**Manufacturer's standard**].
3. Pattern: [**As indicated on Drawings**].
4. Profile: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Integral Horizontal Louver Blinds: Manufacturer's standard, horizontal louver blinds located between glazing units in a dual-glazed system. Provide blinds with aluminum slats and polyester fiber cords that are operated by hardware located on inside face of sash.

1. Operation: [**Tilt only**][**Tilt, raising, and lowering**].
2. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Integral Fabric Shades: Manufacturer's standard, cellular pleated shades located between glazing units in a dual-glazed system. Provide shades with multiple fabric layers forming accordion folds that enclose airspaces between the fabric layers, with polyester fiber cords that are operated by hardware located on inside face of sash.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Jamb Extensions: [**Stain-grade Pacific Hemlock**].

E. Nail Fins: Manufacturer's standard mounting flanges with holes prepunched for mechanical fasteners.

2.12 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: [**Full, inside for project-out**][**Full, outside for double-hung**][**Half, outside for single-hung**][**Full, outside for sliding**][**Half, outside for sliding**] sashes.

B. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
2. Finish for Interior Screens: Baked-on organic coating in [**color selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Finish for Exterior Screens: [**Baked-on organic coating in color selected by Architect from manufacturer's full range**][**Matching color and finish of cladding**], as directed by the Owner.

C. Glass-Fiber Mesh Fabric: [**18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm)**][**20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm)**] mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.

1. Mesh Color: [**Manufacturer's standard**].

D. Aluminum Wire Fabric: **18-by-16 (1.1-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire.

1. Wire-Fabric Finish: [**Natural bright**][**Charcoal gray**][**Black**].

2.13 FABRICATION

A. Fabricate wood windows in sizes indicated. Include a complete system for installing and anchoring windows.

B. Glaze wood windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Window Assemblies: [**Bow**][**Bay**][**Combination**]. Provide window units in configuration indicated. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:

1. Combination and reinforcing mullions with interior and exterior trim.
2. Interior and exterior extension and trim.
3. Clear [**pine**][**birch**] head and seat boards.
4. Top and bottom plywood platforms.
5. Exterior head and sill casings and trim.
6. Support brackets.

E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to

greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WOOD WINDOWS

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Mullions: Install combination and reinforcing mullions for combination assemblies in accordance with manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows must take place as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance to be performed in accordance with AAMA 502.
2. Air-Infiltration Testing:

    a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
    b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**One**][**Three**] window(s) of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows to be tested [**immediately after installation**][**at 5, 50, and 90 percent completion**], as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.
6. Windows will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

B. Clean exposed surfaces immediately after installing windows using manufacturer's written instructions. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

C. Remove and replace sashes if glass has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

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SECTION 08 01 81 10 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass products.
2. Laminated glass.
3. Insulating glass.
4. Glazing sealants.
5. Glazing tapes.
6. Miscellaneous glazing materials.

B. Related Requirements:

1. Section 057313 "Glazed Decorative Metal Railings" for glazing in railings.
2. Section 084126 "All-Glass Entrances and Storefronts."
3. Section 084233 "Revolving Door Entrances" for glass in revolving door entrances.
4. Section 084423 "Structural-Sealant-Glazed Curtain Walls" for glazing sealants used in structural-sealant-glazed curtain walls.
5. Section 088113 "Decorative Glass Glazing."
6. Section 088300 "Mirrors."
7. Section 088813 "Fire-Rated Glazing."
8. Section 088853 "Security Glazing."

1.2 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Glass Samples: For each type of [**glass product other than clear monolithic vision glass**][**the following products**]; **12 inches (300 mm)** square.

1. Tinted glass.
2. Coated glass.
3. Laminated glass.
4. Insulating glass.
5. Spandrel glass.

D. Glazing Accessory Samples: For [**sealants**][**and**][**colored spacers**], in **12-inch (300-mm)** lengths.[**Install sealant Samples between two strips of material representative in color of adjoining framing system.**]

E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

F. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturers of fabricated glass units**][**glass testing agency**][**and**][**sealant testing agency**].

B. Product Certificates: For glass.

C. Product Test Reports: For [**fabricated glass**][**and**][**glazing sealants**], for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved[**and certified**] by primary glass manufacturer.

B. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors[**and who employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Install glazing in mockups specified in [**Section 084113 "Aluminum-Framed Entrances and Storefronts"**][**Section 085113 "Aluminum Windows"**][**Section 084413 "Glazed Aluminum Curtain Walls"**] to match glazing systems required for Project, including glazing methods.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than [**eight**] Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below **40 deg F (4.4 deg C)**.

1.11 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: [**10**] years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: [**10**] years from date of Substantial Completion.

D. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass: Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.

1. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Glass: Obtain [**tinted**][**and**][**coated**] glass from single source from single manufacturer.

B. Source Limitations for Glazing Accessories: For each product and installation method, obtain from

single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: [**As indicated on Drawings**][**Determine design wind pressures applicable to Project in accordance with ASCE/SEI 7, based on heights above grade indicated on Drawings**].

    a. Wind Design Data: As indicated on Drawings.
    b. Basic Wind Speed: [**85 mph (38 m/s)**][**90 mph (40 m/s)**][**100 mph (44 m/s)**][**110 mph (49 m/s)**].
    c. Importance Factor: [**1.0**].
    d. Exposure Category: [**B**][**C**][**D**].

2. Design Snow Loads: [**As indicated on Drawings**].
3. Probability of Breakage for Sloped Glazing: For glass sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or **1 inch (25 mm)**, whichever is less.
5. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

D. Windborne-Debris-Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

F. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites [**6 mm thick**][**of thickness indicated**].
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current

non-beta version of LBL's WINDOW computer program, expressed as **Btu/sq. ft. x h x deg F (W/sq. m x K)**.

5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
6. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

G. Acoustic Performance:

1. Exterior Glazing: [**28**][**33**][**35**] OITC.
2. Interior Glazing: [**35**][**37**][**41**] STC.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA Publications: [**"Laminated Glazing Reference Manual" and**]"Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of [the SGCC][the SGCC or another certification agency acceptable to authorities having jurisdiction][manufacturer]. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum.[**Provide glass that complies with performance requirements and is not less than thickness indicated.**]

1. Minimum Glass Thickness for Exterior Lites: [**6 mm**].
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass[**as needed to comply with "Performance Requirements" Article**]. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass[**as needed to comply with "Performance Requirements" Article**]. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGC Glass Company North America, Inc.**]
b. [**Cardinal Glass Industries, Inc.**]
c. [**Guardian Glass LLC**]
d. [**Pilkington North America; NSG Group**]
e. [**Saint-Gobain Glass Corp**]
f. [**Vitro Architectural Glass**]

B. Low-Iron Annealed Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent[**and SHGC of not less than 0.87**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGC Glass Company North America, Inc.**]
b. [**Guardian Glass LLC**]
c. [**Pilkington North America; NSG Group**]
d. [**Saint-Gobain Glass Corp**]
e. [**Vitro Architectural Glass**]

C. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGC Glass Company North America, Inc.**]
b. [**Guardian Glass LLC**]
c. [**Pilkington North America; NSG Group**]
d. [**Saint-Gobain Glass Corp**]
e. [**Vitro Architectural Glass**]

D. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

E. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

F. Pyrolytic-Coated, Low-Maintenance Glass: Clear float glass with coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cardinal Glass Industries, Inc.**]
b. [**Pilkington North America; NSG Group**]
c. [**Saint-Gobain Glass Corp**]

G. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cardinal Glass Industries, Inc.**]
b. [**Guardian Glass LLC**]
c. [**Pilkington North America; NSG Group**]
d. [**Saint-Gobain Glass Corp**]
e. [**Vitro Architectural Glass**]

H. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in NGA's "Engineering Standards Manual."

I. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

J. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dreamwalls by Gardner Glass Products**]
b. [**Guardian Glass LLC**]
c. [**ICD High Performance Coatings**]
d. [**OldCastle BuildingEnvelope (OBE)**]

K. Reflective- and Low-E-Coated Spandrel Glass: ASTM C1376, Kind CS.

2.5 LAMINATED GLASS

A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dreamwalls by Gardner Glass Products**]
b. [**Kuraray America, Inc.**]
c. [**Pilkington North America; NSG Group**]
d. [**Saflex; Eastman**]

2. Construction: Laminate glass with [polyvinyl butyral interlayer][ionoplast interlayer][cast-in-place and cured-transparent-resin interlayer] to comply with interlayer manufacturer's written

instructions.
3. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
4. Interlayer Color: Clear unless otherwise indicated.

B. Windborne-Debris-Impact-Resistant Laminated Glass: Comply with requirements specified above for laminated glass except laminate glass with[**one of**] the following to comply with interlayer manufacturer's written instructions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Kuraray America, Inc.**]
   b. [**Saflex; Eastman**]

2. Construction: Laminate glass with [polyvinyl butyral interlayer reinforced with polyethylene terephthalate film][ionoplast interlayer][cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film] to comply with interlayer manufacturer's written instructions.
3. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
4. Interlayer Color: Clear unless otherwise indicated.

2.6 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.

1. Sealing System: Dual seal, with [**manufacturer's standard**][**polyisobutylene and polysulfide**][**polyisobutylene and silicone**][**polyisobutylene and hot-melt butyl**][**polyisobutylene and polyurethane**] primary and secondary sealants.
2. Perimeter Spacer: [**Manufacturer's standard spacer material and construction**][**Aluminum with mill or clear anodic finish**][**Aluminum with black, color anodic finish**][**Aluminum with bronze, color anodic finish**][**Aluminum with powdered metal paint finish in color selected by Architect**][**Galvanized steel**][**Stainless steel**][**Polypropylene-covered stainless steel in color selected by Architect**][**Thermally broken aluminum**][**Nonmetallic laminate**][**Nonmetallic tube**][**Silicone with integral desiccant and vapor barrier**], as directed by the Owner.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Saint-Gobain Glass Corp**]
      2) [**Technoform Glass Insulation North America**]
      3) [**Thermix; a brand of Ensinger USA**]

3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.7 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
8. Colors of Exposed Glazing Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of industry colors**], as directed by the Owner.

B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
    b. [**Pecora Corporation**]
    c. [**Sika Corporation**]
    d. [**The Dow Chemical Company**]
    e. [**Tremco Incorporated**]

2. Applications: <**Describe types of glazing applications where sealant is required**>.

C. Neutral-Curing Silicone Glazing Sealant, Class 50: Complying with ASTM C920, Type S, Grade NS, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**Sika Corporation**]
f. [**The Dow Chemical Company**]
g. [**Tremco Incorporated**]

2. Applications: <**Describe types of glazing applications where sealant is required**>.

D. Neutral-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Permathane; a Holcim brand**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**Sika Corporation**]
g. [**The Dow Chemical Company**]
h. [**Tremco Incorporated**]

2. Applications: <**Describe types of glazing applications where sealant is required**>.

E. Acid-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Bostik; Arkema**]
c. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
d. [**Pecora Corporation**]
e. [**Permathane; a Holcim brand**]
f. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
g. [**Sika Corporation**]
h. [**The Dow Chemical Company**]
i. [**Tremco Incorporated**]

2. Applications: <**Describe types of glazing applications where sealant is required**>.

2.8 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:

1. [**EPDM**][**Silicone**] with Shore A durometer hardness of 85, plus or minus 5.
2. Type recommended in writing by sealant or glass manufacturer.

D. Spacers:

1. [**Neoprene**] blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
2. Type recommended in writing by sealant or glass manufacturer.

E. Edge Blocks:

1. [**EPDM**][**Silicone**] with Shore A durometer hardness per manufacturer's written instructions.
2. Type recommended in writing by sealant or glass manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.10 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than **50 inches (1270 mm)**.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide **1/8-inch- (3-mm-)** minimum bite of spacers on glass and use thickness equal to sealant

width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to

lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

A. Clear Glass Type : [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.

1. Minimum Thickness: [**6 mm**].
2. Safety glazing required.

B. Low-Iron Glass Type : [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.

1. Minimum Thickness: [**6 mm**].
2. Safety glazing required.

C. Pyrolytic-Coated, Low-Maintenance Glass Type : Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

1. Minimum Thickness: [**6 mm**].
2. Safety glazing required.

D. Tinted Glass Type : [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.

1. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
2. Minimum Thickness: [**6 mm**].
3. Safety glazing required.

E. Ceramic-Coated Vision Glass Type : [**Heat-strengthened**][**Fully tempered**] float glass.

1. Glass: [**Clear**][**Low-iron**][**Tinted**] float glass.
2. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
3. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
4. Minimum Thickness: [**6 mm**].
5. Coating Location: Second surface.
6. Safety glazing required.

F. Reflective-Coated Vision Glass Type : [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.

1. Kind CV (coated vision glass)[except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m)].
2. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
3. Coating Color: [**Gold**][**Pewter**][**Silver**].
4. Glass: [**Clear**][**Tinted**] float glass.
5. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Minimum Thickness: [**6 mm**].
7. Coating Location: [**First**][**Second**] surface.
8. Low-Maintenance Coating: Pyrolytic coating on first surface.
9. Safety glazing required.

G. Ceramic-Coated Spandrel Glass Type : [**Heat-strengthened**][**Fully tempered**] float glass.

1. Glass: [**Clear**][**Low-iron**][**Tinted**] float glass.
2. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
3. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
4. Minimum Thickness: [**6 mm**].
5. Coating Location: Second surface.
6. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.

H. Silicone-Coated Spandrel Glass Type : [**Heat-strengthened**][**Fully tempered**] float glass.

1. Glass: [**Clear**][**Low-iron**][**Tinted**] float glass.
2. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
3. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's**

samples], as directed by the Owner.
4. Minimum Thickness: [**6 mm**].
5. Coating Location: Second surface.
6. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.

I. Reflective-Coated Spandrel Glass Type : [**Heat-strengthened**][**Fully tempered**] float glass.

1. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
2. Coating Color: [**Gold**][**Pewter**][**Silver**].
3. Glass: [**Clear**][**Low-iron**][**Tinted**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Minimum Thickness: [**6 mm**].
6. Coating Location: [**First**][**Second**] surface.
7. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.
8. Factory apply manufacturer's standard opacifier of the following material to coated on second surface of lites, with resulting products complying with Specification No. 89-1-6 in NGA's "Engineering Standards Manual":

   a. Manufacturer's standard opacifier material.
   b. Polyester film laminated to glass with solvent-based adhesive.

3.9 LAMINATED GLASS SCHEDULE

A. Clear Laminated Glass Type : Two plies of [**annealed**][**heat-strengthened**][**fully tempered**][**low-iron annealed**][**low-iron heat-strengthened**][**low-iron fully tempered**] float glass.

1. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
2. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Safety glazing required.

B. Laminated Tinted Glass Type : Two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass with outer ply tinted and inner ply clear.

1. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
2. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
3. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
4. Safety glazing required.

C. Tinted Interlayer Laminated Glass Type : Two plies of clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass and tinted interlayer.

1. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
2. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Interlayer Color: [**Blue-green**][**Bronze light**][**Gray**].
4. Safety glazing required.

D. Ceramic-Coated, Laminated Vision Glass Type : Two plies of [**heat-strengthened**][**fully tempered**] float glass.

1. Outer Ply: [**Clear**][**Low-iron**][**Tinted**] float glass.
2. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
3. Inner Ply: [**Clear**][**Low-iron**] float glass.
4. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full**

range][**Match Architect's samples**], as directed by the Owner.
5. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
6. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
7. Coating Location: [**Second**][**Third**][**Fourth**] surface.
8. Safety glazing required.

E. Reflective-Coated, Laminated Vision Glass Type : Two plies of [**heat-strengthened**][**fully tempered**] float glass.

1. Kind CV (coated vision glass)[except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m)].
2. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
3. Coating Color: [**Gold**][**Pewter**][**Silver**].
4. Outer Ply: [**Clear**][**Tinted**] float glass.
5. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
7. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
8. Coating Location: [**First**][**Second**][**Third**] surface.
9. Low-Maintenance Coating: Pyrolytic coating on first surface.
10. Safety glazing required.

F. Low-E-Coated, Laminated Vision Glass Type : Two plies of clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

1. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
2. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
4. Safety glazing required.

G. Reflective-Coated, Laminated Spandrel Glass Type : Two plies of [**heat-strengthened**][**fully tempered**] float glass.

1. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
2. Coating Color: [**Gold**][**Pewter**][**Silver**].
3. Outer Ply: [**Clear**][**Tinted**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
6. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
7. Coating Location: [**First**][**Second**][**Third**] surface.

3.10 INSULATING GLASS SCHEDULE

A. Clear Insulating Glass Type :

1. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.
6. Safety glazing required.

B. Low-Iron Insulating Glass Type :

1. Overall Unit Thickness: [1 inch (25 mm)][5/8 inch (16 mm)].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Low-iron [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: Low-iron [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
6. Safety glazing required.

C. Pyrolytic-Coated, Low-Maintenance Insulating Glass Type :

1. Overall Unit Thickness: [1 inch (25 mm)][5/8 inch (16 mm)].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Pyrolytic-coated, low-maintenance, clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.
6. Safety glazing required.

D. Low-E-Coated, Clear Insulating Glass Type :

1. Overall Unit Thickness: [1 inch (25 mm)][5/8 inch (16 mm)].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
6. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
7. Safety glazing required.

E. Pyrolytic-Coated, Low-Maintenance, Low-E-Coated, Clear Insulating Glass Type :

1. Overall Unit Thickness: [1 inch (25 mm)][5/8 inch (16 mm)].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Pyrolytic-coated, low-maintenance, clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.
6. Low-E Coating: [**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
7. Safety glazing required.

F. Tinted Insulating Glass Type :

1. Overall Unit Thickness: [1 inch (25 mm)][5/8 inch (16 mm)].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Tinted [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
7. Safety glazing required.

G. Low-E-Coated, Tinted Insulating Glass Type :

1. Overall Unit Thickness: [1 inch (25 mm)][5/8 inch (16 mm)].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].

3. Outdoor Lite: Tinted [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
7. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
8. Safety glazing required.

H. Ceramic-Coated, Insulating Vision Glass Type :

1. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
2. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
3. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
4. Outdoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron heat-strengthened**][**Low-iron fully tempered**][**Tinted heat-strengthened**][**Tinted fully tempered**] float glass.
5. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Interspace Content: [**Air**][**Argon**].
7. Indoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
8. Coating Location: [**Second**][**Third**][**Fourth**] surface.
9. Safety glazing required.

I. Reflective-Coated Insulating Glass Type :

1. Kind CV (coated vision glass)[except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m)].
2. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
3. Coating Color: [**Gold**][**Pewter**][**Silver**].
4. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
5. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
6. Outdoor Lite: [**Clear annealed**][**Clear heat-strengthened**][**Clear fully tempered**][**Tinted heat-strengthened**][**Tinted fully tempered**] float glass.
7. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
8. Interspace Content: [**Air**][**Argon**].
9. Indoor Lite: Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
10. Coating Location: [**First**][**Second**][**Third**] surface.
11. Low-Maintenance Coating: Pyrolytic coating on first surface.
12. Safety glazing required.

J. [**Ceramic**][**Silicone**]-Coated, Insulating Spandrel Glass Type :

1. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
2. Overall Unit Thickness: [**1 inch (25 mm)**].
3. Minimum Thickness of Each Glass Lite: [**5 mm**][**6 mm**].
4. Outdoor Lite: [**Clear annealed**][**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: [**Clear annealed**][**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
7. Coating Location: Fourth surface.

K. [**Ceramic**][**Silicone**]-Coated, Low-E, Insulating Spandrel Glass Type :

1. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
2. Overall Unit Thickness: [**1 inch (25 mm)**].
3. Minimum Thickness of Each Glass Lite: [**5 mm**][**6 mm**].
4. Outdoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
7. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
8. Opaque Coating Location: Fourth surface.

L. [**Ceramic**][**Silicone**]-Coated, Tinted, Insulating Spandrel Glass Type :

1. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
2. Overall Unit Thickness: [**1 inch (25 mm)**].
3. Minimum Thickness of Each Glass Lite: [**5 mm**][**6 mm**].
4. Outdoor Lite: Tinted [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
5. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Interspace Content: [**Air**][**Argon**].
7. Indoor Lite: Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
8. Coating Location: Fourth surface.

3.11 INSULATING-LAMINATED-GLASS SCHEDULE

A. Clear Insulating, Laminated Glass Type :

1. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**].
2. Minimum Thickness of Outdoor Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Clear [**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
    a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
    b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
6. Safety glazing required.

B. Low-E-Coated, Clear Insulating Laminated Glass Type :

1. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**].
2. Minimum Thickness of Outdoor Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Clear [**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
    a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
    b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29**

mm)].

6. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
7. Safety glazing required.

C. Tinted, Insulating Laminated Glass Type :

1. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**].
2. Minimum Thickness of Outdoor Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Tinted [**heat-strengthened**][**fully tempered**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

    a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
    b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].

7. Safety glazing required.

D. Low-E-Coated, Tinted, Insulating Laminated Glass Type :

1. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**].
2. Minimum Thickness of Outdoor Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Tinted [**heat-strengthened**][**fully tempered**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

    a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
    b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].

7. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
8. Safety glazing required.

E. Reflective-Coated, Insulating Laminated Glass Type :

1. Kind CV (coated vision glass)[except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m)].
2. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
3. Coating Color: [**Gold**][**Pewter**][**Silver**].
4. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**].
5. Minimum Thickness of Outdoor Lite: [**6 mm**].
6. Outdoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Tinted heat-strengthened**][**Tinted fully tempered**] float glass.
7. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
8. Interspace Content: [**Air**][**Argon**].
9. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].

10. Coating Location: [**First**][**Second**][**Third**] surface.
11. Low-Maintenance Coating: Pyrolytic coating on first surface.
12. Safety glazing required.

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SECTION 11 11 36 00 - VEHICLE CHARGING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Offboard electric vehicle charging system equipment.
2. Fleet electric vehicle charging system equipment with bidirectional capability.
3. Onboard electric vehicle supply equipment.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases.
5. Section 260553 "Identification for Electrical Systems" specifies identification products.
6. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and fault current withstand ratings referenced by this Section.
7. [**Section 262726 "Wiring Devices"**][**Section 262726.31 "General-Grade Single Straight-Blade Receptacles"**] specifies 6-50R receptacles.
8. Section 262816 "Enclosed Switches and Circuit Breakers" specifies[**fused**] safety switches.

1.2 DEFINITIONS

A. CCS: Combined charging system; a means for using the same connector port for both AC Level 2 charging and DC Level 3 fast charging.

B. EV: Electric vehicle.

C. EVCE: Electric vehicle charging system equipment. This term refers to DC Level 3 charging equipment located offboard the vehicle.

D. EVSE: Electric vehicle supply equipment. This term refers to AC Level 2 charging equipment that depends on the built-in charger located onboard the vehicle.

E. Fastened in Place: Does not require tools to be removed and replaced.

F. Fixed in Place: Requires tools to be removed and replaced.

G. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

H. OCPP: Open Charge Point Protocol; an application protocol for communication between EVs and a central management system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are not acceptable for submitted product.

2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following:

1. Routing and attachment of permanent wiring.

a. Include plans, elevations, sections, details, and attachments to other work.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

a. Provide Drawings indicating location and number of EV charging units, and distance from building.
b. Provide Drawings indicating "reasonable accessibility" to EV charging units.
c. Provide Drawings indicating location and number of EV charging units, charging levels and connectors, distance from building, signage details, and ability of EV charging units to participate in a demand-response or time-of-use pricing program.
d. Provide Drawings indicating locations for AC Level 2 or greater EV charging equipment installed at each required parking space. Indicate distance from building, signage details, charging levels, types of vehicle connectors provided, and ability of EV charging units to participate in a demand-response or time-of-use pricing program.
e. Provide Drawings indicating locations for 208 to 240 V dedicated branch circuit in minimum Metric Designator 27 (Trade Size 1) conduit terminated in electrical box or enclosure installed and ready for connection to AC Level 2 or greater EV charging equipment at each required parking space.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction test reports.

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for software and firmware upgrades.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Software and firmware service agreement.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.7 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Training and manufacturer certification to install, splice, and terminate communications cabling.
2. Installation Supervisor: BICSI Technician (TECH) certification.
3. Copper Installers: [**30 percent**] of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
4. Fiber Installers: [**30 percent**] of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

E. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**] certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**] testing standards.

1.8 PRECONSTRUCTION TESTING

A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.

B. Preconstruction Test Reports: Collect, assemble, and submit test reports prepared by qualified testing agency.

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that assembled and installed vehicle charging equipment performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that vehicle charging equipment performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**] years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**] years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 OFFBOARD ELECTRIC VEHICLE CHARGING SYSTEM EQUIPMENT

A. Description: EVCE located offboard the vehicle that is designed for providing DC Level 3 fast charging of vehicle batteries.

B. UL FFTG - DC Level 3 EV Charging System Equipment (EVCE) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blink Charging**]
b. [**ChargePoint, Inc.; subsidiary of ChargePoint Holdings, Inc.**]
c. [**Efacec Electric Mobility; company of Efacec Power Solutions, SGPS, S.A.**]
d. [**FLO (FLO Services USA Inc. in USA, and Services FLO Inc. in Canada)/AddÉnergie**

Technologies Inc]
e. [**Loop Global, Inc.**]
f. [**Wallbox USA; subsidiary of Wall Box Chargers S.L.U.**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. EVCE: UL CCN FFTG; including UL 2202.
   b. Personnel Protection: UL CCN FFUQ2; including UL 2231-1 and UL 2231-2.

4. Standard Features: Complies with Article 625 of NFPA 70.
5. Sustainable Design Features:

   a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
   b. Equipment has earned ENERGY STAR product label.
   c. Corporate Sustainability Report: Provide[**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Location Rating: [**Indoor**][**Indoor/outdoor**].
   b. Input Feeder Rating: 480Y/277 V(ac), three phase, 60 Hz, [**30 A**][**70 A**][**80 A**][**100 A**][**200 A**][**250 A**][**500 A**].
   c. Output Quantity: [**1**][**2**].
   d. Output Wiring: Flexible cord.

      1) Output Cable Nominal Length: [**14 ft (4.3 m)**][**25 ft (7.6 m)**].
      2) Cable management system.
      3) Output Attachment Plug: [**CCS Combo 1 (SAE J1772)**][**CCS Combo 2 (IEC 62196-3)**][**and**][**CHAdeMO (Japan)**].

   e. Mounting: [**Concrete base mount**][**As indicated on Drawings**].
   f. Metering: [**Revenue**][**Nonrevenue**] grade meter.
   g. Networking:

      1) Protocol: [**OCPP**].
      2) WAN Communications: Cellular [**GSM**][**LTE**].
      3) LAN Communications: [**802.11 b/g/n WiFi**][**Ethernet**][**Modbus**][**Zigbee**].
      4) Capable of remote configuration and reporting.

   h. Authorization or Payment System:

      1) [**RFID reader**][**NFC reader**][**Bluetooth reader**][**Keypad**][**Proximity card reader**][**in**

accordance with Section 281500 "Integrated Access Control Hardware Devices."][in accordance with Section 281511 "Integrated Credential Readers and Entry Management."]

2) PCI compliant.
3) Capable of remote control and authorization.

7. Accessories:

a. Multifunctional Display: Provide electronic signage integral with charger pedestal that is capable of displaying operating instructions, video advertising, and other messages while charger is in operation.

2.3 FLEET ELECTRIC VEHICLE CHARGING SYSTEM EQUIPMENT WITH BIDIRECTIONAL CAPABILITY

A. Description: EVCE located offboard the vehicle that is designed to use connected vehicle batteries through an inverter for electric utility peak shaving, or for supplying power to premise or load during utility power outage, and to DC Level 3 fast charge those vehicle batteries during off-peak times or when utility power becomes available.

B. UL FFTN - Fleet DC Level 3 EV Charger with Utility Interactive Inverter :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fermata, LLC d/b/a Fermata Energy**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Bidirectional EVCE: UL CCN FFTN; including UL Subject 9741.
b. Grid Interactive Equipment: UL CCN QIKH; including UL 1741.
c. Personnel Protection: UL CCN FFUQ2; including UL 2231-1 and UL 2231-2.

4. Standard Features:

a. Complies with Article 625 of NFPA 70.

5. Sustainable Design Features:

a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
b. Equipment has earned ENERGY STAR product label.
c. Corporate Sustainability Report: Provide[**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
f. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Location Rating: [**Indoor**][**Indoor/outdoor**].
b. Input Feeder Rating: 480Y/277 V(ac), three phase, 60 Hz, [**40 A**][**dual 40 A**].
c. Output Quantity: [**1**][**2**].
d. Output Wiring: Flexible cord.

1) Output Cable Nominal Length: [**13 ft (4 m)**].
2) Output Attachment Plug: [**CHAdeMO (Japan)**].

e. Mounting: [**Pedestal mount**][**Wall mount**][**As indicated on Drawings**].
f. Networking:

1) Protocol: Proprietary.
2) WAN Communications: Cellular.

g. Authorization or Payment System:

1) Keypad.

2.4 ONBOARD ELECTRIC VEHICLE SUPPLY EQUIPMENT

A. Description: EVSE with input rated up to 600 V(ac) for AC Level 2 charging of vehicle batteries using the EV's onboard charger.

B. UL FFWA - AC Level 2 EV Supply Equipment (EVSE) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blink Charging**]
b. [**Bosch Automotive Service Solutions**]
c. [**ChargePoint, Inc.; subsidiary of ChargePoint Holdings, Inc.**]
d. [**ClipperCreek, Inc**]
e. [**Enel X North America, Inc.; Enel Group**]
f. [**EVBox Group; subsidiary of EVBox B.V.**]
g. [**EvoCharge**]
h. [**FLO (FLO Services USA Inc. in USA, and Services FLO Inc. in Canada)/AddÉnergie Technologies Inc**]
i. [**Leviton Manufacturing Co., Inc.**]
j. [**Loop Global, Inc.**]
k. [**Lynkwell**]
l. [**SemaConnect, Inc.; subsidiary of Blink Charging Co.**]
m. [**Siemens Industry, Inc.; Energy and Automation Division**]
n. [**Wallbox USA; subsidiary of Wall Box Chargers S.L.U.**]
o. [**Xeal**]

2. Source Limitations: Obtain products from single manufacturer.

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. EV Supply Equipment: UL CCN FFWA; including UL 2594.
    b. Personnel Protection: UL CCN FFUQ2; including UL 2231-1 and UL 2231-2.

4. Standard Features:

    a. Complies with Article 625 of NFPA 70.

5. Sustainable Design Features:

    a. Equipment has earned ENERGY STAR product label.
    b. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
    c. Corporate Sustainability Report: Provide[**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Location Rating: [**Indoor**][**Indoor/outdoor**].
    b. Input Feeder Rating:

        1) 208 to 240 V(ac), single phase, 60 Hz, [**40 A**][**50 A**][**60 A**][**80 A**][**dual 80 A**][**100 A**].
        2) 208 to 240 V(ac), three phase, 60 Hz, [**40 A**][**60 A**][**100 A**].

    c. Input Feeder Type: [**Hard wired**][**6-50R receptacle**].
    d. Output Quantity: [**1**][**2**].
    e. Output Wiring: Flexible cord.

        1) Output Cable Nominal Length (Usable Length May Be Less): [**18 ft (5.5 m)**][**20 ft (6 m)**][**23 ft (7 m)**][**25 ft (7.6 m)**].
        2) Cable management system.
        3) Output Attachment Plug: [**Type 1 (SAE J1772)**][**Type 2 (IEC 62196-2)**][**and**][**CHAdeMO (Japan)**].

    f. Mounting: [**Concrete base mount**][**Pedestal mount**][**Pole mount**][**Wall mount**][**As indicated on Drawings**].
    g. Metering: [**Revenue**][**Nonrevenue**] grade meter.
    h. Networking:

        1) Protocol: [**OCPP**].
        2) WAN Communications: Cellular [**GSM**][**LTE**].
        3) LAN Communications: [**802.11 b/g/n WiFi**][**Ethernet**][**Modbus**][**Zigbee**].

4) Capable of remote configuration and reporting.

i. Authorization or Payment System:

1) [**RFID reader**][**NFC reader**][**Bluetooth reader**][**Keypad**][**Proximity card reader**][**in accordance with Section 281500 "Integrated Access Control Hardware Devices."**][**in accordance with Section 281511 "Integrated Credential Readers and Entry Management."**]
2) PCI compliant.
3) Capable of remote control and authorization.

7. Accessories:

a. Multifunctional Display: Provide electronic signage integral with charger pedestal that is capable of displaying operating instructions, video advertising, and other messages while charger is in operation.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to the Owner spare parts, for repairing vehicle charging equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

B. Special Tools: Furnish to the Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to vehicle charging equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and bollards or posts for suitable conditions where vehicle charging equipment will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF VEHICLE CHARGING EQUIPMENT

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
6. Electric Vehicle Power Transfer System: Article 625 of NFPA 70 and NECA NEIS 413.
7. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Special Installation Techniques:

1. Hard-Wired Connection: Provide[**fusible**] safety switch, that is lockable in "Off" position, in readily accessible location for termination of input cable.
2. 250 V Plug-In Connection:

    a. Provide 6-50R single receptacle not less than **18 inch (450 mm)** and not more than **4 ft (1.2 m)** above finished floor.
    b. Remove plug and provide[**fusible**] safety switch, that is lockable in "Off" position, in readily accessible location for termination of input cable.

3. Fastened in Place: Comply with manufacturer's published instructions for installing mounting hardware. Provide manufacturer's recommended seismic controls when required for compliance with the Project's requirements.
4. Fixed in Place: Comply with manufacturer's published instructions for installation and torquing of hardware fasteners. Provide manufacturer's recommended seismic controls when required for compliance with the Project's requirements.
5. Base Mounting: When indicated on Drawings or in manufacturer's published instructions, provide concrete bases for installing vehicle charging equipment.
6. Identification: Provide labels for vehicle charging equipment and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Provide warning signs.
    c. Label each enclosure with engraved metal or laminated-plastic nameplate.

D. Cybersecurity:

1. Software:

    a. Coordinate security requirements with [**IT department**][**CIO**].
    b. Ensure that latest stable software release is installed and properly operating.
    c. Disable or change default passwords to password of at least eight characters in length, using a combination of uppercase and lower letters, numbers, and symbols. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

    a. Coordinate location and access requirements with [**IT department**][**CIO**].
    b. Enable highest level of wireless encryption that is compatible with the Owner's information and communications technology network.
    c. Disable dual network connections.

E. Interfaces with Other Work:

1. Coordinate installation of new vehicle charging equipment with existing conditions.
2. Work must be rated to handle available fault current on input feeder.
3. Provide appropriate warning labels for arc-flash hazard on input feeder.

3.3 FIELD QUALITY CONTROL OF VEHICLE CHARGING EQUIPMENT

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical power testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified electrical power testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**], as directed by the Owner.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. For each unit of vehicle charging equipment, perform the following tests and inspections:

a. Unit self-test.
b. Operation test with load bank.
c. Operation test with EV.
d. Network communications test.

F. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**]

system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 PROTECTION

A. After installation, protect vehicle charging equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

3.6 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**] years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**] years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

    a. Upgrade Notice: No fewer than [**30**] days to allow the Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 11 11 36 00

Task	Specification	Specification Description
11 11 36 13	11 11 36 00	Vehicle Charging Equipment

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SECTION 11 12 00 00 - PARKING CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Automatic barrier gates.
2. Vehicle detectors.
3. Traffic controllers.
4. Entry terminals.
5. Exit terminals.
6. Pay stations.
7. Fee computers.
8. Miscellaneous parking control equipment.
9. Parking facility management software.
10. Access control units.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for pipe bollards to protect parking control equipment.
2. Section 133423.16 "Fabricated Control Booths" for cashiers'/parking attendants' booths.
3. Section 281300 "Access Control Software and Database Management" for integrating parking control equipment with building access control.
4. Section 281500 "Access Control Hardware Devices" for parking control equipment access devices.
5. Section 283100 "Intrusion Detection" for integrating parking control equipment with the building intrusion detection system.
6. Section 283121 "Area and Perimeter Intrusion Detection" for integrating parking control equipment with the site security control system.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Verify that equipment operation is consistent with system description.
3. Review sequence of operation for each type of parking control equipment.
4. Review coordination of interlocked equipment specified in this Section and elsewhere.
5. Review required testing, inspecting, and certifying procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for parking control equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished

specialties.

B. Shop Drawings: For parking control equipment.

1. Include plans, elevations, sections and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Vehicle Detectors: Layout and method of placement of vehicle loop detector system.

C. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** square in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each type of exposed finish **6 inches (150 mm)** square in size.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For parking control equipment to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On [**USB media**][**and**][**approved online or cloud solution**].
3. Device address list.
4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Gate Arms: [**Two**] breakaway gate arms for each gate installed, complete with accessory components.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Parking Control System: For the following types of parking management:

1. Transient Parking: Hourly rated parking, with fee paid while [**entering**][**exiting**].
2. Monthly Parking: Monthly rated parking, with fee paid by the month and access gained by access control card.
3. Flat-Rate Parking: Unlimited-duration parking, with free gate entry and fixed-fee amount paid while exiting.
4. Flat-Rate or Hourly Parking: Fee paid at central pay station after parking.
5. Special-Event Parking: Duration-of-event parking, with fee paid while entering with gates up or down.
6. Limited Date and Time Parking: Limited-duration parking, with predetermined fee access control card.
7. Merchant Validated Parking: Fee set, reduced, or waived by merchant validation, with free gate entry and fee paid while exiting.
8. Valet Parking: Assisted parking, with fee paid while entering or exiting.
9. Hotel Guest Parking: Unlimited access for duration of stay, with access gained by access control card.

B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SOURCE LIMITATIONS

A. Obtain [**parking control equipment**] from single source from single manufacturer.

2.3 AUTOMATIC BARRIER GATES

A. Automatic Barrier Gates: Provide parking control device consisting of operator and controller housed in a weathertight, tamper-resistant cabinet enclosure with gate arm. Device shall be activated by a signal from access or revenue control device. Fabricate unit with gate-arm height in down position of not more than **35 inches (889 mm)** above pavement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Automatic Systems**]
d. [**CAME Americas Automation LLC**]
e. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
f. [**Delta Scientific Corporation**]
g. [**DoorKing, Inc**]
h. [**Engineered Parking Systems, Inc**]
i. [**Falcon Eye Global Security, LLC**]
j. [**Hy-Security Gate, Inc.; Nice North America; Nice group**]
k. [**Magnetic AutoControl USA**]
l. [**Parking Systems, Inc.**]

2. Standards: Barrier gate operators that are listed and labeled according to UL 325 by a qualified testing agency.

B. Controller: Factory-sealed, solid-state, plug-in type, with galvanized-steel box for wiring connections. [**Noncommunicating**][**Communicating**] type.

1. Noncommunicating Type:

a. Capable of logic for one- and two-way lanes.
b. Separate momentary contacts for transient patrons, monthly patrons, vehicle entries, and vehicle exits.

2. Communicating Type:

a. Real-time communication of lane counts, status messages, and execute commands.
b. Monitor illegal entries and exits, tailgates, tickets, monthlies, and backouts.
c. Status messages for gate up too long, backouts, ticket in chute, and gate-arm rebound.
d. Communication commands for resetting loops, turning "Full" signs on/off, raising and lowering gate arm, and disabling [**ticket dispensers**][**card readers**][**barcode imagers**][**license plate recognition**][**automatic vehicle identification**].

3. Physical Characteristics:

a. On-off power supply switch.
b. Automatic-manual switch.
c. Differential counter.
d. Communication port.
e. Internal [**resettable**][**non-resettable**] counters.
f. Thermal-overload protection with manual reset.
g. Plug-in connectors for [**two**][**three**] vehicle loop detectors.
h. Thermostatically controlled heater with on/off/auto switch.
i. Thermostatically controlled fan with on/off/auto switch.
j. Switch to test motor and limit switches.
k. Emergency manual disconnect.
l. Battery backup.
m. [**Single**][**Two**][**Four**], 115-V ac grounded power receptacle.

4. Operational Characteristics:

a. Able to store successive inputs and sequentially processing each one.
b. Automatic instant-reversing obstacle detector mechanism that stops downward motion of gate arm if arm contacts or nears an object and that immediately returns arm to upward position. Include a zero- to 60-second, variable-time reset device.
c. Directional arming logic.
d. Broken gate-arm monitoring.
e. Programmable[**automatic**] timer.
f. Diagnostic mode for on-site testing[with LEDs for inputs and outputs].
g. Automatic and continuous testing of inputs and outputs.
h. Reversible arm capability for right- or left-handed operation.

C. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall). Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish [two] keys for each lock[all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

1. Steel Sheet: Not less than 0.097-inch- (2.5-mm-) thick[galvanized-] steel sheet.

    a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch- (3.2-mm-)** thick, aluminum sheet.

    a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch- (2.8-mm-)** thick, stainless-steel sheet.

    a. Finish cabinet exterior with No. 4 finish.

D. Straight Gate Arm: [**1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood**][**0.097-inch- (2.5-mm-) thick steel**][**Fiberglass, PVC, or polycarbonate**][**Aluminum**].

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**10 feet (3.0 m)**][**12 feet (3.7 m)**][**As indicated on Drawings**].
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

E. Folding Gate Arm: Two pieces of **1-by-4-inch nominal- (19-by-89-mm actual-)** size pine or redwood joined together with metal side brackets.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**10 feet (3.0 m)**][**12 feet (3.7 m)**][**As indicated on Drawings**].
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

F. Straight Gate Arm with Counterbalance: **1-by-6-inch nominal- (19-by-140-mm actual-)** size pine or redwood with steel counterweights.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**16 feet (4.9 m)**][**As indicated on Drawings**].
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

G. Wishbone-Style Gate Arm: [**1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood**][**0.097-inch- (2.5-mm-) thick steel**] formed into wishbone configuration, with steel counterweights.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**14 feet (4.3 m)**][**As indicated on Drawings**].
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

H. Operator: UL labeled and listed, [**Class I**][**Class II**][**Class III**][**Class IV**]. [**1/3**][**1/2**] hp; -V, 60-Hz, single-

phase, instant-reversing, continuous-duty motor for operating gate arm. Transmit power to gate-arm drive shaft through the speed reducer to harmonic-acting crank and connecting rod. Fabricate crank, rod, and drive shaft of galvanized solid bar steel. Provide an operable cam for adjusting arm travel.

1. Opening Time: [**Three**][**Six**] seconds.
2. Inherently adjustable, torque limiting clutch for safety.

I. Characteristics:

1. Audible alarm that activates as part of a safety device system.
2. Additional obstruction detector; noncontact [**infrared**][**photoelectric**][**radio-frequency barrier**].
3. Gate-arm warning safety signs on both sides of unit to limit traffic to vehicular traffic.
4. Low-voltage [**yellow**][**red**] warning lights that illuminate when gate is in down position.
5. Low-voltage light on cabinet top that flashes or changes from red to green when barrier gate is operating.
6. LED integrated into gate-arm for increased visibility.
7. Manually operated crank for emergency operation.
8. Gate-arm tip support[**with electromagnetic lock**].
9. Gate-arm skirt bottom[**and top**].

2.4 VEHICLE DETECTORS

A. Vehicle Detectors: Provide detection devices that sense presence or transit of vehicles and emit signals activating gate-arm operators.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Delta Scientific Corporation**]
   d. [**Engineered Parking Systems, Inc**]
   e. [**Magnetic AutoControl USA**]
   f. [**Parking Systems, Inc.**]

B. Vehicle Loop Detector System: Self-tuning electronic presence detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light. Include automatic closing timer with adjustable time delay before closing[timer cut-off switch,] designed to hold gate arm open until traffic clears. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location indicated on Drawings, as recommended in writing by detection system manufacturer for [pave-over][saw-cut] installation.

1. Field-Assembled Loop: Wire, in size indicated for field assembly.
2. Factory-Formed Loop: Wire, preformed in size indicated.
3. Operation:

   a. Recognize vehicles within **6 inches (152 mm)** of each other on standard-sized loop.
   b. Recognize vehicle direction by detecting vehicle moving from one loop to another.
   c. Generate reverse count if vehicle backs up after generating directional count in forward direction.
   d. Continuous diagnostic monitoring [**and memory**]for intermittently operating and failed loops.

e. Crosstalk test between adjacent loops.

C. Active Infrared Vehicle Detector: [Retroreflective][Emitter/receiver]-type presence detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of vehicle in gate-arm pathway by interrupting infrared beam in zone pattern and to emit signal activating gate-arm operator. Include automatic closing timer with adjustable time delay before closing[timer cut-off switch,] and vehicle presence detector designed to hold gate arm open until traffic clears.

2.5 TRAFFIC CONTROLLERS

A. Traffic Controllers: Provide directional enforcement system that allows passage of vehicle in only one direction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ameristar Perimeter Security; ASSA ABLOY**]
b. [**Delta Scientific Corporation**]
c. [**DoorKing, Inc**]
d. [**Engineered Parking Systems, Inc**]
e. [**Falcon Eye Global Security, LLC**]

B. Penetrating Type: System consisting of multiple raised teeth that allow vehicular traffic in one direction and that puncture tires of vehicular traffic in the other direction. Fabricate system from steel plate contained in welded steel frame.

1. Mounting: [**Surface**][**Recessed**].
2. Operation: [**Manual, with each tooth controlled by torsion spring**][**Electromechanical**][**Hydraulic**].
3. Latch Down: Allow disarming for two-way traffic flow. Furnish [**one**] tool(s) for latch-down operation.
4. Illuminated Warning Signs: [Single][Double]-faced warning signs consisting of LED lamps [with photo cell control]and keyed on/off override switches, contained in welded steel bodies with baked-enamel or powder-coat finish and fiberglass sign faces[with flood lamp].

a. Post Mounting: Provide [**in-ground**][**surface-mounted**] base sleeves and posts.
b. Sign Copy: [**"Wrong Way, Stop, Severe Tire Damage."**][**"Warning, Do Not Back Up, Tire Damage."**]

5. Speed Bumps: [**Composite plastic**][**Compression molded rubber compound**] for speed reduction to **5 mph (8 km/h)** or less.

C. Nonpenetrating Type: System consisting of steel curb that allows traffic in only one direction. Fabricate system from steel plate contained in welded steel frame.

1. Mounting: [**Surface**][**Recessed**].
2. Operation: [**Manual**][**Electromechanical**][**Hydraulic**].

2.6 ENTRY TERMINALS

A. Entry Terminals: Provide entry terminals with mechanisms, components, and controllers housed in cabinet enclosures.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amano Cincinnati, Inc**]
    b. [**ASPS Access Security & Parking Systems Inc.**]
    c. [**CAME Americas Automation LLC**]
    d. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
    e. [**Engineered Parking Systems, Inc**]
    f. [**Falcon Eye Global Security, LLC**]
    g. [**Parking Systems, Inc.**]
    h. [**Zeag; HUB Parking Technology; FAAC Group**]

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.
3. Time Indicator: 24-hour cycle with [**A.M. and P.M.**][**military-time**] clock mechanism.
4. Voice annunciation.
5. Tickets: [**Standard paper**][**Magnetic stripe**][**Barcode**].
6. Removable ticket tray with capacity of [**5000**] fan-folded tickets.
7. Battery backup for clock and RAM memory.
8. Communication port.
9. Thermostatically controlled heater with on/off/auto switch.
10. Thermostatically controlled fan with on/off/auto switch.
11. Ticket printing and dispensing mechanism.
12. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
13. Access card reader.
14. Multiple ticket option for valet parking.
15. Intercom.
16. Pinhole camera.
17. Barcode imager scanner.
18. Proximity access reader.
19. Automatic vehicle identification reader.
20. License plate recognition.

C. Operational Characteristics:

1. Operation: [**Standalone**][**Online communication to remote computer**].
2. Activation by [**button with "Push for Ticket" message**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**].

    a. On activation by button, unit automatically records entry time[license plate,] and date on ticket,[sounds buzzer,] dispenses ticket, and raises barrier gate.
    b. On activation by means other than button, credentials are recorded and signal is automatically sent to raise barrier gate.

3. Credit card pay on entry.
4. Automatic ticket validation.
5. Programmable ticket numbering.
6. Programmable facility code.
7. Programmable display.

8. Programmable timer for closing barrier gate.
9. Built-in-service diagnostics.
10. Low-ticket alarm.
11. Out-of-ticket alarm.
12. Ticket jam detection.
13. Test ticket printing.
14. Back-out ticket function.
15. Cancel transaction function.

D. Cabinets: Fabricated from sheet metal with seams welded and ground smooth, approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall); consisting of base and top components. Provide single, gasketed access door for each base component with flush-mounted locks. Furnish [two] keys for each lock[all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet. Fabricate top component so it can be unlocked and opened for ticket loading and maintenance. Include flush-mounted lock in rear of top, keyed the same as base component lock.

1. Steel Sheet: Not less than 0.097-inch- (2.5-mm-) thick[galvanized-] steel sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch-** **(3.2-mm-)** thick, aluminum sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch-** **(2.8-mm-)** thick, stainless-steel sheet.

   a. Finish cabinet exterior with No. 4 finish.

E. Ticket-Dispensing Mechanisms: Removable assembly, with [self-sharpening ticket cutter][ticket burster] and plug-in controller.

2.7 EXIT TERMINALS

A. Exit Terminals: Provide exit terminals with controllers and components housed in cabinet enclosures.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**CAME Americas Automation LLC**]
   d. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   e. [**Engineered Parking Systems, Inc**]
   f. [**Parking Systems, Inc.**]
   g. [**Zeag; HUB Parking Technology; FAAC Group**]

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.

3. Voice annunciation.
4. Battery backup for clock and RAM memory.
5. Communication port.
6. Thermostatically controlled heater with on/off/auto switch.
7. Thermostatically controlled fan with on/off/auto switch.
8. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
9. Access card reader.
10. Ticket reader.
11. Receipt printer.
12. Intercom.
13. Pinhole camera.
14. Barcode imager scanner.
15. Proximity access reader.
16. Automatic vehicle identification reader.
17. License plate recognition.

C. Operational Characteristics:

1. [**Standalone**][**Online communication to remote computer**].
2. Activation by [**ticket insertion**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**].
3. Activation results in the following:

    a. Valid Prepaid Exit: Signal is automatically sent to raise barrier gate.
    b. Pay at Exit: Parking fee is calculated and displayed for payment.
    c. Invalid Exit: Activation is rejected and "Pay Cashier First" or "Return to Cashier" message is displayed.

4. Programmable lost ticket function.
5. Display fee.
6. Accept payment by [**credit card**][**debit card**][**smart card**][**prepaid value card**][**scanned media**][**and**][**merchant ticket**].
7. Accept discounted coupons.
8. Print receipts on demand.
9. Programmable facility code.
10. Programmable grace period.
11. Programmable display.
12. Programmable timer for closing barrier gate.
13. Reports for events and exception events.
14. Programmable merchant validations.
15. Built-in service diagnostics.
16. Cancel transaction function.

D. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall). Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish [two] keys for each lock[all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

1. Steel Sheet: Not less than 0.097-inch- (2.5-mm-) thick[galvanized-] steel sheet.

    a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch-** **(3.2-mm-)** thick, aluminum sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch-** **(2.8-mm-)** thick, stainless-steel sheet.

   a. Finish cabinet exterior with No. 4 finish.

2.8 PAY STATIONS

A. Pay Stations: Provide self-contained, cashiering [**central**][**entry**][**exit**] pay stations designed for self-service operation; with mechanisms, components,[**controllers,**] and fee computers housed in a combined enclosure.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   d. [**Engineered Parking Systems, Inc**]
   e. [**Parking Systems, Inc.**]
   f. [**Zeag; HUB Parking Technology; FAAC Group**]

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.
3. Voice annunciation.
4. Battery backup for clock and RAM memory.
5. Thermostatically controlled heater with on/off/auto switch.
6. Thermostatically controlled fan with on/off/auto switch.
7. Ticket printing and dispensing mechanism.
8. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
9. Bill acceptor.
10. Access card reader.
11. Ticket reader.
12. Printer.
13. Intercom.
14. Pinhole camera.
15. Barcode imager scanner.
16. Proximity access reader.
17. Automatic vehicle identification reader.
18. License plate recognition.

C. Operational Characteristics:

1. [**Standalone**][**Online communication to remote computer**].
2. Activation by [**ticket insertion**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**].

3. Activation results in the following:

    a. Valid Prepayment: Signal is automatically sent to raise barrier gate.
    b. Payment Prompt: Parking fee is calculated and displayed for payment.

4. Compute multiple parking fees based on recorded entry times.
5. Compute multiple taxes by percentage and fixed amount.
6. Programmable lost ticket function.
7. Display fee.
8. Accept payment by cash and [**credit card**][**debit card**][**scanned media**][**smart card**][**prepaid value card**][**and**][**merchant ticket**].
9. Accept discounted coupons.
10. Compute change.
11. Print receipts on demand.
12. Print validation on ticket.
13. Print audit trail.
14. Programmable for up to [**six**] fee structures.
15. Test mode to verify accuracy of fee structure program.
16. Programmable time.
17. Programmable facility code.
18. Programmable grace period.
19. Programmable display.
20. Programmable timer for closing barrier gate.
21. Programmable merchant validations.
22. Built-in service diagnostics.
23. Print cash audit, revenue, operational, and statistical reports on demand.
24. Duress alarm output for emergencies.
25. Cancel transaction function.

D. Cabinets: Fabricated from cold-rolled steel sheet with seams welded and ground smooth, approximately 36 inches wide by 18 inches deep by 60 inches tall (914 mm wide by 457 mm deep by 1524 mm tall). Provide single, gasketed access door with flush-mounted locks. Furnish [two] keys for each lock[all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

    1. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

2.9 FEE COMPUTERS

A. Fee Computers: Provide modular[**PC-based**] system. Register permanent record of each transaction in computer's memory.

    1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        a. [**Amano Cincinnati, Inc**]
        b. [**ASPS Access Security & Parking Systems Inc.**]
        c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
        d. [**Engineered Parking Systems, Inc**]
        e. [**Falcon Eye Global Security, LLC**]
        f. [**Parking Systems, Inc.**]

g. [**Zeag; HUB Parking Technology; FAAC Group**]

B. Physical Characteristics:

1. Touchscreen display.
2. Battery backup for clock and RAM memory.
3. Communication port.
4. [**Cash drawer**][**Two cash drawers**].
5. Standard ticket reader.
6. Magnetic stripe ticket reader.
7. Barcode ticket reader.
8. Credit card reader[**with smart card reader**].
9. Access card reader.
10. Proximity access reader.
11. Automatic Vehicle Identification reader.
12. License plate recognition.
13. [**Keyed**][**Keyless-membrane**] keypad.
14. Detachable printer.

C. Operational Characteristics:

1. Compute multiple parking fees based on entry times on ticket from ticket dispenser.
2. Compute multiple taxes by percentage and fixed amount.
3. Programmable lost ticket function.
4. Display fee on remote fee display device.
5. Credit card in/out.
6. Accept payment by cash and [**credit card**][**debit card**][**smart card**][**prepaid value card**][**and**][**merchant ticket**].
7. Accept discounted coupons.
8. Control independent cash drawer.
9. Compute change.
10. Print receipts.
11. Print validation on ticket.
12. Print audit trail.
13. Reload value cards.
14. Interface to automatic barrier gate.
15. Programmable with up to [**six**] fee structures.
16. Programmable time.
17. Programmable keys.
18. Programmable for special events validations.
19. Programmable for automatic activation for limited date and time validations.
20. Programmable merchant validations.
21. Programmable valet parking.
22. Programmable hotel guest parking.
23. Three levels of security including cashier, supervisor, and master.
24. Recall last transaction.
25. Test mode to verify accuracy of fee structure program.
26. Built-in service diagnostics.
27. View cash audit, revenue, operational, and statistical reports on screen or print on demand.
28. Duress alarm output for emergencies.

D. Cash Drawer: Fabricated with a removable tray and drawer, with five compartments for paper currency and five compartments for coins.

E. Remote Fee Display: Single-faced signs designed for use with fee computer, consisting of **1-inch- (25-mm-)** tall, digital displays or LCDs contained in welded steel bodies with baked-enamel or powder-coat

finish.

1. Messages: Amount due, "Thank You," "Closed," and time in A.M./P.M. format.
2. Mounting: [**Front of cashier's booth**][**42-inch- (1067-mm-) high pedestal**].

2.10 MISCELLANEOUS PARKING CONTROL EQUIPMENT

A. "Lot Full" Signs : Single-faced signs consisting of illumination source contained in welded steel bodies with extended hood and baked-enamel finish. Sign copy shall be [**4 (102)**] **inches (mm)** tall.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ASPS Access Security & Parking Systems Inc.**]
    b. [**CAME Americas Automation LLC**]
    c. [**Engineered Parking Systems, Inc**]

2. Type: [**Flashing**][**Nonflashing**].
3. Operation: [**Manual by push button**][**Automatic by barrier gate controller**].
4. Illumination: [**Traffic signal lamps and colored**][**LED bulb and clear**] acrylic sign face.
5. Mounting: [**Top of barrier gate cabinet**][**42-inch- (1067-mm-) high pedestal**].

2.11 PARKING FACILITY MANAGEMENT SOFTWARE

A. Parking Facility Management Software: Manufacturer's standard software that is compatible with security-access control system and that provides automatic facility monitoring, supervision, and remote control of parking control equipment from one or more locations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amano Cincinnati, Inc**]
    b. [**ASPS Access Security & Parking Systems Inc.**]
    c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
    d. [**WPS Parking Systems; Dynniq Group**]

B. Operation:

1. Collect data for revenue and activity reporting.
2. Collect data for access and space control.
3. Notification services.
4. On-line prepaid parking.
5. Event management.
6. Validation solutions.
7. License plate recognition systems.
8. Pay-by-phone.
9. Loyalty programs.
10. Track tickets.
11. Programmable parking control equipment.

2.12 ACCESS CONTROL UNITS

A. Access Control Units: Provide access control unit that activates barrier gates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
d. [**DoorKing, Inc**]
e. [**Engineered Parking Systems, Inc**]
f. [**Falcon Eye Global Security, LLC**]
g. [**Nortek Security & Control, LLC**]
h. [**Parking Systems, Inc.**]

B. Unit Housing: Fabricate from [**welded cold-rolled steel or aluminum sheet**][**plastic**] with weatherproof front access panel equipped with flush-mounted lock and [**two**] keys. Provide face-lighted unit fully visible at night.

1. Steel Finish: Manufacturer's standard baked-enamel or powder-coat finish system.

C. Card Reader Controlled Unit: Functions only when authorized card is presented.

1. System: [**Magnetically coded, single-code system activated by coded card**][**Programmable, multiple-code capability permitting validation or voiding of individual cards**].

a. Permit four different access time periods.

2. Reader Type: [Swipe][Proximity].

a. Swipe reader for [**magnetic-stripe**][**barcode**][**Wiegand**] cards.
b. Insertion reader for [**magnetic-stripe**][**barcode**][**Wiegand**] cards.
c. Proximity reader for proximity cards.

3. Operation: [**Standalone**][**Online communication to remote parking control system computer**][**Online communication to remote security-access control system computer**].
4. Characteristics: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing barrier gate activity**][**Digital display or LCD**][**Programmable by PDA (personal digital assistant) by infrared interface**].
5. Mounting: [**With pedestal**][**Wall**][**In enclosed cabinet**][**As indicated on Drawings**].

D. Digital Keypad Controlled Unit: Functions only when authorized code is entered on [**keyed**][**keyless-membrane**] keypad.

1. System: [**Multiple-code capability**][**Programmable, multiple-code capability**].

a. Multiple-code capability of no fewer than [**five**][**100**][**500**] possible individual codes.
b. Programmable, multiple-code capability permitting validation or voiding of no fewer than [100][2500][10,000] possible individual codes, consisting of [one to six] digits[and permitting four different access time periods].

2. Operation: [**Standalone**][**Online communication to remote parking control system computer**][**Online communication to remote security-access control system computer**].

3. Characteristics: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing barrier gate activity**].
4. Mounting: [**With pedestal**][**Wall**][**As indicated on Drawings**].

E. Radio-Controlled System: Digital access control system consisting of code-compatible universal coaxial receiver[one per barrier gate][where indicated on Drawings], remote antenna with coaxial cable and mounting brackets, and [one permanently mounted][four portable] transmitter(s) per receiver designed to operate barrier gates. Provide programmable transmitter with multiple-code capability permitting validation or voiding of no fewer than [1000][10,000] codes per channel configured for the following functions:

1. Transmitters: [**Single-button**][**Triple-button**] operated.

a. Single-button operated with [**open**][**open and close**] functions.
b. Triple-button operated with open, close, and stop functions.

1) Provide transmitters featuring [**two**][**three**][**four**] independent channel settings controlling separate receivers for operating more than one barrier gate from each transmitter.

2.13 ANCHORAGES

A. Anchor Bolts: [**Galvanized**][**Stainless steel**].

1. Hot-dip galvanized according to ASTM A153/A153M and ASTM F2329/F2329M.
2. Stainless steel, [**Type 304**][**Type 316**][**Type 304 or 316 as indicated**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including equipment bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before parking control equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Excavation for Traffic Controllers: Saw cut existing pavement for recessed traffic controllers and hand-excavate recesses to dimensions and depths and at locations as required by traffic controller manufacturer's written instructions and as indicated on Drawings.

3.3 INSTALLATION, GENERAL

A. Install parking control equipment as required for complete and integrated installation.

1. Rough-in electrical connections.

3.4 INSTALLATION OF AUTOMATIC BARRIER GATES

A. Anchor cabinets to concrete bases with anchor bolts or expansion anchors, and mount barrier gate arms.

1. Install barrier gates according to UL 325.

3.5 INSTALLATION OF VEHICLE DETECTORS

A. [**Cut grooves in pavement and bury**][**Bury**] and seal wire loop at locations indicated on Drawings according to manufacturer's written instructions. Connect to parking control equipment operated by detector.

3.6 INSTALLATION OF TRAFFIC CONTROLLERS

A. Anchor controllers to [**recessed concrete bases**][**driveway surfaces**] with anchor bolts or expansion anchors.

3.7 INSTALLATION OF ENTRY TERMINALS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.8 INSTALLATION OF EXIT TERMINALS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.9 INSTALLATION OF PAY STATIONS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.10 INSTALLATION OF FEE COMPUTERS

A. Install computers at locations indicated, including connecting to peripheral equipment[**and remote computers**].

3.11 INSTALLATION OF CARD READER PEDESTALS

A. [**Pad**][**In-ground**] mount with mounting bolts.

3.12 INSTALLATION OF ELECTRICAL

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Parking control equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.14 ADJUSTING

A. Adjust parking control equipment to function smoothly, and lubricate as recommended by manufacturer.

B. Confirm that locks engage accurately and securely without forcing or binding.

C. After completing installation of exposed, factory-finished parking control equipment, inspect exposed finishes and repair damaged finishes.

3.15 PROTECTION

A. Remove barrier gate arms during the construction period to prevent damage, and install them immediately before Substantial Completion.

3.16 MAINTENANCE SERVICE

A. Maintenance Service Description: Beginning at Substantial Completion, maintenance service shall

include [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of parking control equipment Installer**][**manufacturer's authorized service representative**]. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper parking control equipment operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.17 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [**two**] years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**] years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**] days to allow the Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.18 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain parking control equipment.

END OF SECTION 11 12 00 00

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Task	Specification	Specification Description
11 12 16 00	11 12 00 00	Parking Control Equipment
11 12 16 00	13 34 23 16	Fabricated Control Booths
11 12 23 00	11 12 00 00	Parking Control Equipment
11 12 23 00	13 34 23 16	Fabricated Control Booths
11 12 26 00	11 12 00 00	Parking Control Equipment
11 12 26 13	11 12 00 00	Parking Control Equipment
11 12 26 13	13 34 23 16	Fabricated Control Booths
11 12 33 00	11 12 00 00	Parking Control Equipment
11 12 33 13	11 12 00 00	Parking Control Equipment
11 12 36 00	11 12 00 00	Parking Control Equipment

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SECTION 11 13 13 00 - LOADING DOCK BUMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes loading dock bumpers.

B. Related Requirements:

1. Section 111319 "Stationary Loading Dock Equipment" for loading dock bumpers that are integral with dock levelers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of loading dock bumper.

B. Shop Drawings: For dock bumpers. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 LOADING DOCK BUMPERS

A. Dock Bumpers: Surface-mounted bumpers; of type, size, and construction indicated; designed to absorb kinetic energy and minimize damage to loading dock structure.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Floor Products Company, Inc**]
b. [**Beacon Industries, Inc**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**Durable Corporation**]
e. [**Hugger Dock Equipment Company; Columbus Foam Products, Inc.**]
f. [**Kelley; Entrematic; ASSA ABLOY**]
g. [**Pioneer Dock Equipment**]
h. [**Rite-Hite Holding Corporation**]
i. [**Rotary Products Inc**]
j. [**Serco; Entrematic; ASSA ABLOY**]
k. [**Super Seal Mfg. Ltd**]
l. [**Vestil Manufacturing Company**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Laminated-Tread Loading Dock Bumper : Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel

end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

1. Thickness: [**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**].
2. Horizontal Style: [**6 inches (152 mm)**][**10 inches (250 mm)**][**12 inches (305 mm)**] high by [**length indicated on Drawings**].
3. Vertical Style: **8 inches (203 mm)** wide by [**20 inches (508 mm) high**][**24 inches (610 mm) high**][**36 inches (914 mm) high**][**height indicated on Drawings**].

C. Molded-Rubber Loading Dock Bumpers : Fabricated from molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240; of size and configuration indicated. Fabricate units with not less than two predrilled anchor holes.

1. Configuration: [**T shape**][**Inverted-L shape**][**Square**][**Rectangular**][**As indicated on Drawings**].
2. Thickness: [**2 inches (50 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**].

D. Extruded-Rubber Loading Dock Bumpers : Fabricated from ASTM D2000, extruded synthetic rubber with Shore A durometer hardness of 75, plus or minus 5, when tested according to ASTM D2240; of size and configuration indicated. Furnish units with predrilled anchor holes and concealed, flat, steel mounting bar.

1. Configuration: [**Flat or ribbed, with 2-inch (50-mm) nominal thickness and 9-inch (229-mm) height**][**4-1/2-inch- (114-mm-) wide base and 4-inch (102-mm) depth with half-oval shape that compresses and returns to original shape**][**As indicated on Drawings**].

E. Steel-Face, Laminated-Tread Loading Dock Bumpers : Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires and with **3/8-inch (9.5-mm)** steel faceplate of same size as rubber surface. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles. Weld faceplate to two steel support brackets, which shall extend back to and engage **3/4-inch- (19-mm-)** diameter support rods in elongated holes, allowing steel face to float on impact.

1. Thickness: [**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**].
2. Horizontal Style: [**6 inches (152 mm)**][**10 inches (250 mm)**][**12 inches (305 mm)**] high by [**length indicated on Drawings**].
3. Vertical Style: **8 inches (203 mm)** wide by [**20 inches (508 mm) high**][**24 inches (610 mm) high**][**36 inches (914 mm) high**][**height indicated on Drawings**].

F. Anchorage Devices: Galvanized-steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated. Hot-dip galvanized according to ASTM A153/A153M or ASTM F2329/F2329M.

G. Materials: ASTM A36/A36M for steel plates, shapes, and bars. Hot-dip galvanize according to ASTM A123/A123M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Loading Dock Bumpers: Attach loading dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.

1. Welded Attachment: Plug-weld anchor holes in contact with steel inserts and fillet weld at other locations.
2. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.
3. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.

3.3 ADJUSTING

A. After completing installation of exposed, factory-finished dock bumpers, inspect exposed finishes and repair damaged finishes.

END OF SECTION 11 13 13 00

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SECTION 11 13 16 00 - LOADING DOCK SEALS AND SHELTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Foam-pad loading dock seals.
2. Inflatable loading dock seals.
3. Frame-type loading dock shelters.
4. Inflatable loading dock shelters.
5. Transparent-strip door curtains.

1.2 COORDINATION

A. Coordinate sizes and configurations of dock seals with finish grade slopes, walls, dock configuration, doors, dock bumpers, and other adjacent construction.

B. Coordinate sizes, configurations, and mounting of transparent-strip door curtains with walls, doors, dock levelers, and other adjacent construction.

C. Electrical System Roughing-in: Coordinate layout and installation of motor/blower and activation switch with connections to power supplies[**and interlock to other dock equipment**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include electrical characteristics of inflatable blower motor.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of anchors and field connection.
3. Include diagrams for power, signal, and control wiring of inflatable blower motor.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For each type of fabric indicated.

E. Samples for Verification: For each type of fabric indicated.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inflatable units to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of dock openings and contiguous construction by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FOAM-PAD LOADING DOCK SEALS

A. Foam-Pad Dock Seals: Dock seals consisting of fabric-covered foam pads designed to compress **4 to 5 inches (102 to 127 mm)** under pressure of truck body to form an airtight seal at jambs and head of loading dock openings; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**Fairborn U.S.A., Inc.**]
e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**McGuire; Systems, LLC**]
g. [**Nordock Inc.**]
h. [**NOVA Technology International, L.L.C.**]
i. [**Pentalift Equipment Corporation**]
j. [**Pioneer Dock Equipment**]
k. [**Rite-Hite Holding Corporation**]
l. [**Rotary Products Inc**]
m. [**Serco; Entrematic; ASSA ABLOY**]
n. [**Super Seal Mfg. Ltd**]
o. [**Vestil Manufacturing Company**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Stationary Head Pad: [8 inches (203 mm)][12 inches (305 mm)][18 inches (457 mm)][24 inches (610 mm)] high and same depth as jamb pads[beveled]; sized for opening width.

C. Adjustable Head Pad: [**18 inches (457 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**] high and same depth as jamb pads; sized for opening width; with manufacturer's standard hardware and tension spring or counterweight mechanism for adjusting pad height.

D. Jamb Pads: [**Square**][**Beveled; tapered to reduce opening width**][**V-shaped**].

1. Nominal Size: [**8 inches (203 mm) wide**][**12 inches (305 mm) wide**][**As indicated on**

Drawings] and sized for opening height.

E. Construction: Consisting of single- or double-ply, coated, fabric-covered, urethane-foam core with supporting frame. Fabricate jamb and head pads of same depth and sized for opening width.

1. Wood Support Frame: Factory-painted[pressure-treated] wood; with steel mounting hardware.
2. Steel Support Frame: Steel channel frame of manufacturer's standard weight, shape, and finish; with steel mounting hardware.

    a. Steel Finish: Hot-dip galvanize components to comply with the following:

        1) ASTM A123/A123M for iron and steel support framing.
        2) ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

3. Tapered Side Panels: Taper side panels to angle required to accommodate sloped loading dock approach grades, and make sealing edge of dock seal parallel to back edge of truck. Taper for [**declined approach**][**inclined approach**][**approach as indicated on Drawings**].
4. Guide Strips: **4-inch- (102-mm-)** wide, coated, nylon guide strips on jamb pads.
5. Pleated Protectors: On face of jamb pads of overlapping layers of coated fabric attached to base fabric; [**4-inch (102-mm)**][**8-inch (203-mm)**][**16-inch (406-mm)**] wear exposure.
6. Reinforcing: Manufacturer's standard reinforcing over cover fabric on [**upper corners**][**inside face of jamb pads**][**inside and full face of jamb pads and upper corners**] of dock seal.

F. Materials:

1. Vinyl-Coated Nylon Cover Fabric: Minimum total weight of [**22 oz./sq. yd. (746 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**].

    a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

        1) High-Visibility Layer: Manufacturer's standard yellow or orange layer.

2. Neoprene-Coated Nylon Cover Fabric: Minimum total weight of [**16 oz./sq. yd. (543 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**][**45 oz./sq. yd. (1526 g/sq. m)**].

    a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

        1) High-Visibility Layer: Manufacturer's standard yellow or orange layer.

3. Hypalon-Coated Nylon Cover Fabric: Minimum total weight of [**16 oz./sq. yd. (543 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**].

    a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

        1) High-Visibility Layer: Manufacturer's standard yellow or orange layer.

4. Cover Fabric: Manufacturer's proprietary cover fabric complying with the following minimum requirements:

a. Tearing strength of not less than [**300 by 300 (1334 by 1334)**] **lbf (N)** when tested according to ASTM D2261.
b. Abrasion resistance of not less than [**6000**] cycles when tested according to FED-STD-191A-5306.
c. Tensile strength of not less than [**1200 by 1200 (5338 by 5338)**] **lbf (N)** when tested according to FED-STD-191A-5100.1.
d. Cold resistance to **minus 40 deg F (minus 40 deg C)** when tested according to FED-STD-191A-5874.
e. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

1) High-Visibility Layer: Manufacturer's standard yellow or orange layer.

5. Pleated Protectors: Same fabric as cover.
6. Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried.
7. Pressure-Treated Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried, and pressure treated with waterborne preservatives to comply with AWPA U1; Use Category UC3.

a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

2.3 INFLATABLE LOADING DOCK SEALS

A. Inflatable Dock Seals: Inflatable dock seals consisting of one-piece jamb[sill,] and header seals designed to inflate by motor/blower and compress against truck bodies to form airtight seals at loading dock openings; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kelley; Entrematic; ASSA ABLOY**]
b. [**Pentalift Equipment Corporation**]
c. [**Serco; Entrematic; ASSA ABLOY**]
d. [**Super Seal Mfg. Ltd**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Head Members: [**One**][**Two**].

C. Jamb Members: [**One**][**Two**].

D. Construction: Fabricate header seal full width over jamb seals. Mount seals on pressure-treated wood frame with hot-dip galvanized-steel mounting hardware. Inflate seals by use of 1/2-hp motor/blower mounted above header seal in galvanized-steel hood with separate manual on/off activation switch with indicator light. [**Provide electrical interlock.**]Provide bottom of header and jamb seals with grommets to allow for release of moisture and excess air.

E. Materials:

1. Neoprene-Coated Nylon Fabric: Minimum total weight of **14 oz./sq. yd. (475 g/sq. m)**.

a. Color: [**Black**][**Gray**][**Blue**][**Brown**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Fabric: Manufacturer's proprietary fabric complying with the following minimum requirements:

a. Tearing strength of not less than [**110 by 85 (489 by 378)**] **lbf (N)** when tested according to ASTM D2261.
b. Abrasion resistance of not less than [**490**] cycles when tested according to FED-STD-191A-5306.
c. Tensile strength of not less than [**500 by 440 (2224 by 1957)**] **lbf (N)** when tested according to FED-STD-191A-5100.1.
d. Cold resistance to **minus 40 deg F (minus 40 deg C)** when tested according to FED-STD-191A-5874.
e. Color: [**Black**][**Gray**][**Blue**][**Brown**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Steel Finish: Hot-dip galvanize components to comply with the following:

1. ASTM A123/A123M for iron and steel support framing.
2. ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

2.4 FRAME-TYPE LOADING DOCK SHELTERS

A. Frame-Type Dock Shelters: Dock shelters designed to form a seal with sides and top of truck body while leaving entire width and height of truck's rear opening unobstructed; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**Fairborn U.S.A., Inc.**]
e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**McGuire; Systems, LLC**]
g. [**Nordock Inc.**]
h. [**NOVA Technology International, L.L.C.**]
i. [**Pentalift Equipment Corporation**]
j. [**Pioneer Dock Equipment**]
k. [**Rite-Hite Holding Corporation**]
l. [**Rotary Products Inc**]
m. [**Serco; Entrematic; ASSA ABLOY**]
n. [**Super Seal Mfg. Ltd**]
o. [**Vestil Manufacturing Company**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Rigid-Frame Type: Fabricated from [**fabric-covered**][**fiberglass**] side and top panels attached to fixed supporting framework. Provide head and side curtains with built-in flexible stays, wind straps between head curtain and side frame, pleated protectors, reinforcing, and guide strips. Slope head frame from

center for drainage. Provide replaceable, fabric-covered, tapered, foam-bottom pads and protective steel bumpers of size and type required for application shown.

C. Flexible-Frame Type: Fabricated from fabric-covered side and top panels attached to retractable supporting framework with independent spring-tension extension arms. Provide head and side curtains with built-in flexible stays, pleated protectors, reinforcing, and guide strips. Provide replaceable, fabric-covered, tapered, foam-bottom pads of size and type required for application shown.

D. Head-Pad Height: [**12 inches (305 mm)**][**18 inches (457 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**].

E. Construction: Fabricate framework, pads, bumpers, fabric for curtains and panels, and other components to sizes and shapes indicated or required to fit door-opening sizes shown, and allow for not less than **18 inches (457 mm)** of truck-body penetration when truck is docked.

1. Wood Framework: Factory painted; mechanically fastened together using nails and lag bolts or metal connectors to form a rigid assembly.
2. Steel Framework: Zinc-plated steel tubing of size and thickness standard with manufacturer, with joints welded.

    a. Steel Finish: Hot-dip galvanize components to comply with the following:

        1) ASTM A123/A123M for iron and steel support framing.
        2) ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

3. Top and Side Panels:

    a. White, translucent fiberglass, **0.045 inch (1.1 mm)** thick, weighing **6 oz./sq. ft. (1831 g/sq. m)**.
    b. White, translucent vinyl, weighing **14 oz./sq. ft. (4272 g/sq. m)**.

4. Tapered Side Panels: Taper side panels to angle required to accommodate sloped loading dock approach grades, and make sealing edge of dock shelter parallel to back edge of truck. Taper for [**declined**][**inclined**] approach.
5. Guide Strips: **4-inch- (102-mm-)** wide, coated, nylon guide strips on side curtains.
6. Pleated Protectors: On head curtain of overlapping layers of coated fabric attached to base fabric.
7. Reinforcing: Manufacturer's standard reinforcing over cover fabric on side curtains [**and top cover**]of dock shelter.

F. Fabric:

1. Vinyl-Coated Nylon Cover Fabric: Minimum total weight of [**22 oz./sq. yd. (746 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**].

    a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Polyurethane-Coated Nylon Cover Fabric: Minimum total weight of **25 oz./sq. yd. (848 g/sq. m)**.

    a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Neoprene-Coated Nylon Cover Fabric: Minimum total weight of [**16 oz./sq. yd. (543 g/sq. m)**][**40**

oz./sq. yd. (1356 g/sq. m)][45 oz./sq. yd. (1526 g/sq. m)].

a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Hypalon-Coated Nylon Cover Fabric: Minimum total weight of [**16 oz./sq. yd. (543 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**].

a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Cover Fabric: Manufacturer's proprietary cover fabric complying with the following minimum requirements:

a. Tearing strength of not less than [**300 by 300 (1334 by 1334)**] **lbf (N)** when tested according to ASTM D2261.
b. Abrasion resistance of not less than [**6000**] cycles when tested according to FED-STD-191A-5306.
c. Tensile strength of not less than [**1200 by 1200 (5338 by 5338)**] **lbf (N)** when tested according to FED-STD-191A-5100.1.
d. Cold resistance to **minus 40 deg F (minus 40 deg C)** when tested according to FED-STD-191A-5874.
e. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

6. Pleated Protectors: Same fabric as cover.

G. Accessories:

1. Buffer flaps.
2. Bottom filler curtain.
3. Bottom seal pads.

2.5 INFLATABLE LOADING DOCK SHELTERS

A. Inflatable Dock Shelters: Inflatable dock shelters designed to inflate by blower and compress against truck bodies to form airtight seals at loading dock openings; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**air Locke Dock Seal**]
b. [**Kelley; Entrematic; ASSA ABLOY**]
c. [**Nordock Inc.**]
d. [**Pentalift Equipment Corporation**]
e. [**Rite-Hite Holding Corporation**]
f. [**Serco; Entrematic; ASSA ABLOY**]
g. [**Super Seal Mfg. Ltd**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Rigid Canopy: Consisting of rigid canopy, fabric-covered header curtain, and one-piece inflatable header and jamb seals. Fabricate canopy from white, translucent plastic attached to rigid support framework.

C. Rigid Canopy and Sides: Consisting of rigid canopy and sides, fabric-covered header curtain, and one-piece, inflatable header and jamb seals. Fabricate canopy and sides from white, translucent plastic attached to rigid support framework.

D. Construction: Fabricate header seal full width over jamb seals. Mount seals on pressure-treated wood frame with hot-dip galvanized-steel mounting hardware. Provide header curtain with built-in flexible stays and two guide strips. Slope canopy frame from center for drainage. Provide two protective steel bumpers of size and type required for application shown. Inflate seals by use of a 1/2-hp motor/blower, mounted under canopy frame with separate manual on/off activation switch with indicator light.[**Provide electrical interlock.**] Provide bottom of header and jamb seals with grommets to allow for release of moisture and excess air.

1. Shape and Size: Fabricate framework, fabric for curtains, and other components to sizes and shapes indicated or required to fit door-opening sizes shown, and allow for not less than **12 inches (305 mm)** of truck-body penetration when truck is docked.
2. Wood Framework: Fasten members together mechanically, using nails and lag bolts or metal connectors to form a rigid assembly.
3. Steel Framework: Zinc-plated steel tubing of size and thickness standard with manufacturer, with joints welded.

    a. Steel Finish: Hot-dip galvanize components to comply with the following:

        1) ASTM A123/A123M for iron and steel support framing.
        2) ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

4. Guide Strips: **4-inch- (102-mm-)** wide, coated, nylon guide strips on header curtain.

E. Materials:

1. Fabric:

    a. [**Polyurethane**][**Vinyl**]; minimum total weight of **14 oz./sq. yd. (475 g/sq. m)**.

        1) Color: [**Black**][**Green**][**Blue**][**Brown**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

    b. Manufacturer's proprietary fabric complying with the following minimum requirements:

        1) Tearing strength of not less than [**110 by 85 (489 by 378)**] **lbf (N)** when tested according to ASTM D2261.
        2) Abrasion resistance of not less than [**490**] cycles when tested according to FED-STD-191A-5306.
        3) Tensile strength of not less than [**500 by 440 (2224 by 1957)**] **lbf (N)** when tested according to FED-STD-191A-5100.1.
        4) Cold resistance to **minus 40 deg F (minus 40 deg C)** when tested according to FED-STD-191A-5874.
        5) Color: [**Black**][**Green**][**Blue**][**Brown**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 TRANSPARENT-STRIP DOOR CURTAINS

A. Transparent-Strip Door Curtains: Door curtains consisting of overlapping strips suspended from top of opening to form a sealed door curtain. Provide strips of length required to suit opening height and with sufficient unit number to close opening width with overlap indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Floor Products Company, Inc**]
b. [**Chalfant Sewing Fabricators, Inc**]
c. [**Chase Doors; a Senneca Company**]
d. [**Rotary Products Inc**]
e. [**Super Seal Mfg. Ltd**]
f. [**Verilon Vinyl**]
g. [**Vestil Manufacturing Company**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Strip Material: Curved, clear, transparent, extruded PVC. Fabricate strips for manufacturer's standard method of attachment to overhead mounting system indicated.

1. Standard Grade: Designed to withstand temperature range of **0 to plus 150 deg F (minus 18 to plus 66 deg C)**.
2. Low-Temperature Grade: USDA accepted; designed to withstand temperature range of **minus 30 to plus 150 deg F (minus 34 to plus 66 deg C)**.
3. Strip Dimensions: [**6 inches (152 mm) and 0.060 inch (1.5 mm)**][**8 inches (203 mm) and 0.080 inch (2 mm)**][**12 inches (305 mm) and 0.120 inch (3 mm)**][**16 inches (406 mm) and 0.160 inch (4 mm)**] width and thickness, respectively.
4. Overlap: [**None**][**One-third**][**One-half**][**Two-thirds**][**Three-quarters**][**Full**].

C. Header Mounting: Consisting of an angle bolted or welded to opening lintel; equip angle with permanently attached mounting pins and a steel-angle or -plate retaining strip attached to angle with wing nuts.

D. Steel-Plate Wall Surface Mounting: Consisting of a steel plate bolted to side of lintel; equip plate with permanently attached, threaded, mounting pins and steel-angle or -plate retaining strip attached to plate with wing nuts.

E. Steel-Pipe Wall Surface Mounting: Consisting of steel pipe attached to side of lintel by manufacturer's standard, winged-U-type suspension brackets.

F. Wall Surface Mounting: Consisting of a rigid, vinyl, wall-mounting unit bolted to side of lintel above opening; equip unit with a similarly formed, rigid, vinyl retainer attached to unit with wing nuts.

G. Wall Offset Mounting: Consisting of an angle bolted to face of wall projecting out on each side of door opening to allow hanging strips to clear overhead door hood. Equip angle with permanently attached mounting pins and a steel angle or plate retaining strip attached to angle with wing nuts. Return hanging strips to face of wall at jambs to fully enclose space interior to overhead door.

H. Steel Finish: Hot-dip galvanize components to comply with the following:

1. ASTM A123/A123M for iron and steel support mounting.
2. ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical systems for inflatable units to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Coordinate electrical connections with Division 26 Sections.

3.3 INSTALLATION OF FOAM PAD LOADING DOCK SEALS

A. Attach dock-seal support frames securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure compression of dock seals when trucks are positioned against dock bumpers.

3.4 INSTALLATION OF LOADING DOCK SHELTERS

A. Attach dock shelters securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure an effective seal of dock-shelter curtains with sides and top of truck body when trucks are positioned against dock bumpers.

3.5 INSTALLATION OF INFLATABLE LOADING DOCK SEALS

A. Attach dock-seal support frames securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure compression of dock seals when trucks are positioned against dock bumpers.

3.6 INSTALLATION OF FRAME-TYPE LOADING DOCK SHELTERS

A. Attach dock shelters securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure an effective seal of dock-shelter curtains with sides and top of truck body when trucks are positioned against dock bumpers.

3.7 INSTALLATION OF INFLATABLE LOADING DOCK SHELTERS

A. Attach dock shelters securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure an effective seal of dock-shelter curtains with sides and top of truck body when trucks are positioned against dock bumpers.

3.8 INSTALLATION OF TRANSPARENT-STRIP DOOR CURTAINS

A. Attach door-curtain mounting system to lintel with screw anchors or toggle bolts. Mount curtain strips to overlap.

3.9 ADJUSTING

A. After completing installation, inspect exposed factory finishes and repair damaged finishes.

END OF SECTION 11 13 16 00

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Task	Specification	Specification Description
11 13 16 13	11 13 16 00	Loading Dock Seals and Shelters
11 13 16 23	11 13 16 00	Loading Dock Seals and Shelters

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SECTION 11 13 19 00 - STATIONARY LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Recessed loading dock levelers.
2. Edge-of-dock loading dock levelers.
3. Top-of-dock loading dock levelers.
4. Vertical-storing loading dock levelers.
5. Truck levelers.
6. Stationary loading dock lifts (scissor lifts).
7. Truck restraints.
8. Light communication systems.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for [**curb angles at edges of recessed pits**][**and**][**loading dock platform edge channels**].
2. Section 083323 "Overhead Coiling Doors" for coiling overhead doors electrically interlocked to dock levelers.
3. Section 083613 "Sectional Doors" for sectional overhead doors electrically interlocked to dock levelers.
4. Section 111313 "Loading Dock Bumpers" for loading dock bumpers that are not integral with loading dock levelers.
5. Section 111316 "Loading Dock Seals and Shelters" for loading dock seals and shelters.
6. Section 111323 "Portable Dock Equipment" for portable loading dock lifts.

1.2 DEFINITIONS

A. Operating Range: Maximum amount of travel above and below the loading dock level.

B. Working Range: Recommended amount of travel above and below the loading dock level for which loading and unloading operations can take place.

1.3 COORDINATION

A. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation

B. Coordinate installation of cast-in-place items. Furnish setting drawings and templates.

C. Electrical System Roughing-in: Coordinate layout and installation of loading dock equipment with connections to power supplies[**and interlocked equipment**].

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of loading dock equipment.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for stationary loading dock equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For stationary loading dock equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of anchors and each field connection.
3. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Product Test Reports: For each dock leveler, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Indicate compliance of dock levelers with requirements in MH 30.1 for determining rated capacity based on comprehensive testing within last two years of current products.
2. Submittal Form: According to MH 30.1.

D. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For stationary loading dock equipment to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Maintenance Proximity: Not more than [**one**][**two**] hours' normal travel time from Installer's place of business to Project site.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with stationary loading dock equipment, including [**recessed pit dimensions**][**slopes of driveways**][**and**][**heights of loading docks**], by field measurements before fabrication.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace dock levelers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including cracked or broken structural support members, load-bearing welds, and front and rear hinges.
b. Faulty operation of operators, control system, or hardware.
c. Deck plate failures including cracked plate or permanent deformation in excess of **1/4 inch (6 mm)** between deck supports.
d. Hydraulic system failures including failure of hydraulic seals and cylinders.

2. Warranty Period for Structural Assembly: [**10**] years from date of Substantial Completion.
3. Warranty Period for Hydraulic System: [**Four**][**Five**] years from date of Substantial Completion.
4. Warranty shall be for unlimited usage of leveler for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.1 RECESSED LOADING DOCK LEVELERS

A. Recessed Loading Dock Levelers: Recessed, hinged-lip-type dock levelers designed for permanent installation in concrete pits preformed in the edge of loading platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**DLM; Systems, LLC**]

e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**McGuire; Systems, LLC**]
g. [**Nordock Inc.**]
h. [**NOVA Technology International, L.L.C.**]
i. [**Pentalift Equipment Corporation**]
j. [**Pioneer Dock Equipment**]
k. [**Poweramp; System, LLC**]
l. [**Rite-Hite Holding Corporation**]
m. [**Rotary Products Inc**]
n. [**Serco; Entrematic; ASSA ABLOY**]
o. [**Vestil Manufacturing Company**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.1[except for structural testing to establish rated capacity].

D. Rated Capacity: Capable of supporting total gross load of [**20,000 (9072)**][**25,000 (11 340)**][**30,000 (13 608)**][**45,000 (20 412)**] **lb (kg)** without permanent deflection or distortion.

E. Platform: Not less than [**3/16- (5-)**][**1/4- (6-)**][**3/8- (9.5-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Platform Width: [**72 inches (1829 mm)**][**78 inches (1981 mm)**][**84 inches (2134 mm)**][**As indicated on Drawings**]
2. Platform Length: [**72 inches (1829 mm)**][**96 inches (2438 mm)**][**120 inches (3048 mm)**][**As indicated on Drawings**].
3. Frame: [**Manufacturer's standard**][**Clean-pit type, designed to support leveler at sides of pit, with no supports at front of pit floor**].
4. Toe Guards: Equip open sides of dock leveler over range indicated with steel toe guards.

    a. Toe-Guard Range: Entire upper [**operating**][**working**] range.

F. Hinged Lip: Not less than [**1/2- (13-)**][**5/8- (16-)**][**3/4- (19-)**][**1- (25-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube[**and grease fittings**], with gussets on lip and ramp for support.
2. Safety Barrier Lip: Designed to protect material-handling equipment from an accidental fall from loading platform edge of the dock leveler when the leveler is not in use.

G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:

    a. Above Adjoining Platform: [**12 inches (305 mm)**][**18 inches (457 mm)**][**As indicated on Drawings**].
    b. Below Adjoining Platform: [**12 inches (305 mm)**][**14 inches (356 mm)**][**As indicated on Drawings**].

2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall

compensate automatically for canted truck beds of up to **4 inches (102 mm)** over width of ramp.

4. Lip Operation: Manufacturer's standard mechanism, which automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck and automatically retracts lip when truck departs.

    a. Length of Lip Extension: Not less than **12 inches (305 mm)** from face of dock bumpers and not less than) [**16 inches (406 mm)**][**18 inches (457 mm)**][**20 inches (508 mm)**][**dimension indicated on Drawings**] measured from ramp edge.

5. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs.
6. Interlock: Leveler does not operate while [**overhead door is in closed position**][**leveler night lock is engaged**][**truck restraint is not engaged**][**inflatable dock seal is not inflated**][**and**][**inflatable dock shelter is not inflated**].

H. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with an upward-biased-spring counterbalancing mechanism controlled by a hold-down device. Ramp raises to top limit of operating range by operating recessed control handle in ramp to disengage hold-down device. Ramp lowers below platform level with lip retracted by operating auxiliary, recessed control handle to release support legs.

1. Free-Fall Protection: Manufacturer's standard protection system to limit free fall of loaded ramps with front edge supported by truck bed.

I. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than **3 inches (76 mm)**.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
2. Remote-Control Station with Emergency Stop: [**Weatherproof multibutton**][**Multibutton**] control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. Ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

    a. Dual-Panel Control Station: Remote-control station for operating side-by-side dock levelers.
    b. Master Panel: Control panel with integral fused disconnecting means for operating dock leveler, dock door, and truck restraints.

3. Independent Lip Operation: Electric-powered hydraulic raising and hydraulic lowering of lip, controlled independent of raising and lowering of ramp.

J. Electric Operating System: Electric control from a remote-control station; motorized operation. Electric activation for raising of ramp and automatic extending of lip. Equip leveler with a packaged unit including a unitized electric motor and shaft assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
2. Remote-Control Station with Emergency Stop: [**Weatherproof multibutton**][**Multibutton**] control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. Ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

K. Air-Bag Operating System: Electric control from a remote-control station; pneumatic operation. High-volume, low-pressure lifting of ramp. Equip leveler with a packaged unit including a PVC-coated, reinforced polyester lifting bag and two-stage, single-speed electric fan of proper size, type, and operation for capacity of leveler indicated. Include dock-leveler supports controlled by release chain for lowering ramp below platform level without extending lip.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 4**] box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.

L. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

1. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.
2. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.

M. Integral Molded-Rubber Dock Bumpers: Fabricated from [**4- (102-)**][**6- (152-)**] **inch- (mm-)** thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

N. Integral Laminated-Tread Dock Bumpers: Fabricated from [**4-1/2- (114-)**][**6- (152-)**] **inch- (mm-)** thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

O. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

P. Dock-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**][**Spray zinc metallized**].

1. Toe Guards: Baked-on factory finish.

Q. Accessories:

1. Curb Angles: **3-by-3-by-1/4-inch (76-by-76-by-6-mm)** galvanized-steel curb angles for edge of recessed leveler pit, with **1/2-inch- (13-mm-)** diameter by **6-inch- (152-mm-)** long concrete anchors welded to angle at **6 inches (152 mm)** o.c.
2. Self-Forming Pan: Manufacturer's standard prefabricated, self-forming[**spray zinc metallized**] steel form system for poured-in-place construction of concrete pit.
3. Night Locks: Manufacturer's standard means to prevent extending lip and lowering ramp when overhead doors are locked.
4. Side and rear weatherseals.
5. Foam insulation under dock-leveler platform.
6. [**Abrasive skid-resistant**][**Smooth**] surface.

2.2 EDGE-OF-DOCK LOADING DOCK LEVELERS

A. Edge-of-Dock Loading Levelers: Surface-mounted, hinged-lip-type, edge-of-dock levelers designed for permanent installation on face of loading dock platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Bluff Manufacturing, Inc**]
d. [**Chalfant Sewing Fabricators, Inc**]
e. [**DLM; Systems, LLC**]
f. [**Kelley; Entrematic; ASSA ABLOY**]
g. [**McGuire; Systems, LLC**]
h. [**Nordock Inc.**]
i. [**NOVA Technology International, L.L.C.**]
j. [**Pentalift Equipment Corporation**]
k. [**Pioneer Dock Equipment**]
l. [**Poweramp; System, LLC**]
m. [**Rite-Hite Holding Corporation**]
n. [**Rotary Products Inc**]
o. [**Serco; Entrematic; ASSA ABLOY**]
p. [**Vestil Manufacturing Company**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.1[except for structural testing to establish rated capacity].

D. Rated Capacity: Capable of supporting total gross load of [**20,000 (9072)**][**25,000 (11 340)**][**30,000 (13 608)**] **lb (kg)** without permanent deflection or distortion.

E. Platform Ramp Width: [**66 inches (1676 mm)**][**72 inches (1829 mm)**][**78 inches (1981 mm)**][**84 inches (2134 mm)**][**As indicated on Drawings**].

F. Hinged Lip: Not less than [**3/8- (9.5-)**][**7/16- (11-)**][**1/2- (13-)**] **inch- (mm-)** thick, nonskid steel tread plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube[**and grease fittings**], with gussets on lip and ramp for support.

G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:

a. Above Adjoining Platform: [**5 inches (127 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**].
b. Below Adjoining Platform: [**5 inches (127 mm)**][**As indicated on Drawings**].

2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to **3 inches (76 mm)** over width of ramp.
4. Lip Operation: Manufacturer's standard mechanism, which automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck and automatically retracts lip when truck departs.

a. Length of Lip Extension: Not less than **12 inches (305 mm)** from face of dock bumpers and not less than [**15 inches (381 mm)**][**17 inches (432 mm)**][**dimension indicated on Drawings**] measured from ramp edge.

5. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs. Leveler shall be capable of retracting to stored position while truck is at loading dock.

H. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with a torsion-spring counterbalancing mechanism controlled by a hold-down device.

1. Lever Handle: Self-storing lever handle for raising unloaded ramp with minimal lifting force by pulling lever back to extend lip and pushing lever forward to lower ramp and lip.
2. Removable Lifting Handle: For raising unloaded ramp by lifting action.

I. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than **3 inches (76 mm)**.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp and lip raise to vertical position and extend to truck bed by depressing and holding button.

J. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- and formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

1. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in

stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.

2. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.

K. Integral Molded-Rubber Dock Bumpers: Fabricated from [**4- (102-)**][**6- (152-)**] **inch- (mm-)** thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

L. Integral Laminated-Tread Dock Bumper: Fabricated from [**4-1/2- (114-)**][**6- (152-)**] **inch- (mm-)** thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

M. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

N. Dock-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**][**Spray zinc metallized**].

O. Accessories:

1. Self-forming pan.
2. Cast-in-place design.
3. Run-off guards.
4. Ramp approach plate.
5. [**Interlock to truck restraint**][**Key switch**].

2.3 TOP-OF-DOCK LOADING DOCK LEVELERS

A. Top-of-Dock Loading Dock Levelers: Surface-mounted, hinged-lip-type, top-of-dock levelers designed for permanent installation on top edge of loading dock platform without concrete pit; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**DLM; Systems, LLC**]
c. [**Pioneer Dock Equipment**]
d. [**Rotary Products Inc**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a

qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.1[except for structural testing to establish rated capacity].

D. Rated Capacity: Capable of supporting total gross load of [**20,000 (9072)**][**25,000 (11 340)**] **lb (kg)** without permanent deflection or distortion.

E. Platform Width: [**72 inches (1829 mm)**][**As indicated on Drawings**].

F. Hinged Lip: Not less than [**3/8- (9.5-)**][**7/16- (11-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube[**and grease fittings**], with gussets on lip and ramp for support.

G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with a minimum working range of [**10 (254)**] **inches (mm)** above and [**4 (102)**] **inches (mm)** below adjoining platform level.
2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Lip Operation: Manufacturer's standard mechanism, which automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck and automatically retracts lip when truck departs.

    a. Length of Lip Extension: Not less than **12 inches (305 mm)** from face of dock bumpers and not less than [**15 inches (381 mm)**][**dimension indicated on Drawings**] measured from ramp edge.

4. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs. Leveler shall be capable of retracting to stored position while truck is at loading dock.

H. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with a torsion-spring counterbalancing mechanism controlled by a hold-down device.

1. Removable Lifting Hook: For raising unloaded ramp by lifting action and pushing forward to lower ramp and lip.

I. Hydraulic Operating System: Electric control from a remote-control station, fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 12**] box. Ramp and lip raise to vertical position and extend to truck bed by depressing and holding button.

J. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- and formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

K. Integral Molded-Rubber Dock Bumpers: Fabricated from [4- (102-)][6- (152-)] inch- (mm-) thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

L. Integral Laminated-Tread Dock Bumpers: Fabricated from [4-1/2- (114-)][6- (152-)] inch- (mm-) thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- (19-mm-) diameter, steel supporting rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles.

M. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade 55 (380).
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

N. Dock-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**][**Spray zinc metallized**].

2.4 VERTICAL-STORING LOADING DOCK LEVELERS

A. Vertical-Storing Loading Dock Levelers: Recessed, hinged-lip-type, vertical-storing dock levelers designed for permanent installation in shallow concrete pits preformed in the edge of loading platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Giant Equipment Corporation**]
b. [**Kelley; Entrematic; ASSA ABLOY**]
c. [**McGuire; Systems, LLC**]
d. [**Pentalift Equipment Corporation**]
e. [**Poweramp; System, LLC**]
f. [**Rite-Hite Holding Corporation**]
g. [**Serco; Entrematic; ASSA ABLOY**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.1[except for structural testing to establish rated capacity].

D. Rated Capacity: Capable of supporting total gross load of [40,000 (18 144)][45,000 (20 412)][50,000 (22 680)] lb (kg) without permanent deflection or distortion.

E. Platform: Not less than [3/16- (5-)][1/4- (6-)] inch- (mm-) thick, nonskid steel plate.

1. Platform Width: [72 inches (1829 mm)][84 inches (2134 mm)][**As indicated on Drawings**].

2. Platform Length: [**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**][**As indicated on Drawings**].

F. Hinged Lip: Not less than [**1/2- (13-)**][**5/8- (16-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube[**and grease fittings**], with gussets on lip and ramp for support.

G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:

a. Above Adjoining Platform: [**6 inches (152 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**][**As indicated on Drawings**].
b. Below Adjoining Platform: [**6 inches (152 mm)**][**As indicated on Drawings**].

2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to **4 inches (102 mm)** over width of ramp.
4. Lip Operation: Manufacturer's standard mechanism that automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck, and automatically retracts lip when truck departs.

a. Length of Lip Extension: Not less than **12 inches (305 mm) from face of dock bumpers and not less than)**[**16 inches (406 mm)**][**18 inches (457 mm)**][**20 inches (508 mm)**][**dimension indicated on Drawings**] measured from ramp edge.

H. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than **3 inches (76 mm)**. Provide mechanical lock that prevents leveler from lowering without hydraulic pressure.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 12**] box. Ramp lowers at a controlled rate.
2. Remote-Control Station with Emergency Stop: [**Weatherproof multibutton**][**Multibutton**] control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, [**Type 12**] box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. Ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

a. Master Panel: Control panel with integral fused disconnecting means for operating dock leveler, dock door, and truck restraints.

3. Independent Lip Operation: Electric-powered hydraulic raising and lowering of lip, controlled independent of raising and lowering of ramp.

I. Construction: Fabricate dock-leveler frame, platform supports,[**run-off guards,**] and lip supports from

structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

J. Integral Molded-Rubber Dock Bumpers: Fabricated from [**4- (102-)**][**6- (152-)**] **inch- (mm-)** thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

K. Integral Laminated-Tread Dock Bumpers: Fabricated from [**4-1/2- (114-)**][**6- (152-)**] **inch- (mm-)** thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

L. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

M. Dock-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**][**Spray zinc metallized**].

N. Accessories:

1. Interlock: Leveler does not operate while [**overhead door is in closed position**][**and**][**truck restraint is not engaged**].
2. Curb Angles: **3-by-3-by-1/4-inch (76-by-76-by-6-mm)** galvanized-steel curb angles for edge of recessed leveler pit, with **1/2-inch- (13-mm-)** diameter by **6-inch- (152-mm-)** long concrete anchors welded to angle at **6 inches (152 mm)** o.c.

2.5 TRUCK LEVELERS

A. Truck Levelers: Two-cylinder, hydraulic ramp designed to raise and lower end of truck at loading dock. Equip leveler with a packaged unit including a unitized electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity indicated. Provide manufacturer's standard means for limiting loaded ramp's free fall.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Lifts, Inc**]
b. [**Autoquip Corporation**]
c. [**Beacon Industries, Inc**]
d. [**Kelley; Entrematic; ASSA ABLOY**]
e. [**Pentalift Equipment Corporation**]
f. [**Poweramp; System, LLC**]
g. [**Rite-Hite Holding Corporation**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Rated Capacity: Capable of supporting total gross load of [**50,000 (22 680)**][**55,000 (24 948)**][**60,000 (27 216)**][**65,000 (29 484)**] **lb (kg)** without permanent deflection or distortion.

D. Travel Speed: Leveler raises and lowers at **3 fpm (0.015 m/s)**, measured at traveling end.

E. Surface-Mounted Units: Designed for mounting on surface of concrete driveway.

F. Shallow-Pit-Mounted Units: Designed for mounting in sloping shallow pit; capable of **18 inches (457 mm)** of vertical travel above and below level of driveway.

G. Full-Pit-Mounted Units: Designed for installation in a fully recessed pit, with top of platform in stored position flush with driveway.

1. Provide removable plate for access to pit for service.

H. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Self-contained, electric-powered hydraulic raising and hydraulic lowering of lift.

1. Remote-Control Station: Weatherproof, multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, [**Type 12**] box.

a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.

I. Construction: Fabricate truck leveler from structural- and formed-steel shapes; fabricate platform from nonskid steel plate. Construct platform with notch at loading dock end to provide clearance for truck restraint.

1. Cylinders: Equip truck leveler with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.

J. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

K. Truck-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**].

2.6 STATIONARY LOADING DOCK LIFTS

A. Stationary Loading Dock Lifts: Stationary, scissors-type, single-leg, hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Lifts, Inc**]
    b. [**Autoquip Corporation**]
    c. [**Beacon Industries, Inc**]
    d. [**Blue Giant Equipment Corporation**]
    e. [**Kelley; Entrematic; ASSA ABLOY**]
    f. [**Pentalift Equipment Corporation**]
    g. [**Presto Lifts Inc.**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: MH 29.1.

D. Rated Capacity: Lifting capacity of not less than [**8000 lb (3629)**][**load indicated on Drawings**] with axle loads of [**6500 lb (2948 kg) at ends and 5000 lb (2268 kg) at sides**][**magnitudes indicated on Drawings**].

E. Platform: [**Nonskid, safety-tread**][**Smooth-surface**] heavy[**hot-dip galvanized-**] steel deck plate.

1. Platform Size: [**72 inches (1829 mm) long by 72 inches (1829 mm) wide**][**96 inches (2438 mm) long by 72 inches (1829 mm) wide**][**120 inches (3048 mm) long by 72 inches (1829 mm) wide**][**As indicated on Drawings**].
2. Platform Guarding: [**Bevel toe guards**][**Toe sensor**][**Indicator bar**][**Skirts**][**Enclosure**] to comply with requirements in MH 29.1.
3. [**Removable**][**Fixed**] Guard Rails: Provide [**steel**][**hot-dip galvanized-steel**][**aluminum**] guard rails on two sides of platform with a single, removable chain across each end. Provide guard rails not less than **39 inches (991 mm)** high with midrail and **4-inch- (102-mm-)** high, kick plate at bottom.[**Mount rail sockets flush with platform surface.**]

F. Bridge: [**Nonskid, safety-tread steel**][**Nonskid, safety-tread, hot-dip galvanized-steel**][**High-tensile aluminum**] plate.

1. Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform. Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.
2. Size: [**18 inches (457 mm) long by 60 inches (1524 mm) wide**][**18 inches (457 mm) long by 72 inches (1829 mm) wide**][**As indicated on Drawings**].
3. Locations: [**Ends**][**Sides**][**As indicated on Drawings**].

G. Function: Dock lifts shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel and Travel Speed: As indicated on Drawings.
2. Vertical Travel: Maximum of [**60 (1524)**] **inches (mm)** from a lowered height of [**12 (305)**] **inches (mm)** for a total raised height of [**72 (1829)**]**inches (mm)**.
3. Travel Speed: Nominal raising speed of [**8 (0.04)**][**10 (0.05)**][**12 (0.06)**]**fpm (m/s)**.
4. Hinged Throw-over Bridge Operation: [**Manual**][**Spring assist**][**Manual-assist bridge winch**][**Automatic powered**].

H. Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.

1. Power Unit: Consisting of continuous-duty motor, high-pressure gear pump, valve manifold, oil-line filters, and oil reservoir.

    a. Equip manifold with relief valve, check valve, pressure-compensated flow-control valve, and solenoid valve and with provisions for lowering lift manually if power fails.
    b. Equip reservoir, valve manifold, and pressure line with oil-line filters.

2. Cylinders: Equip lift with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement-plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.

    a. Rate of Descent Protection: Pressure-compensated flow control or hydraulic velocity fuse to limit down speed for each cylinder.

3. Remote-Control Station: Multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, [**Type 12**] box.

    a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.

I. Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.

1. Scissors Mechanism: Fabricate leg members from heavy,[**hot-dip galvanized-**] steel-formed tube or plate members to provide maximum strength and rigidity.
2. Scissors Configuration: [**Single leg**][**Multiple width**][**Multiple length**].
3. Bearings: Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.
4. Maintenance Leg: Removable, safety maintenance leg or hinged, safety maintenance bars.
5. Mounting: [**Surface**][**Pit**].

J. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.

K. Dock Lift Finish: Manufacturer's standard baked-on factory finish unless otherwise indicated.

2.7 TRUCK RESTRAINTS

A. Truck Restraints: Manufacturer's standard device designed to engage truck's rear-impact guard and hold truck at loading dock. Restraint shall consist of an iron or steel restraining arm that raises until contacting rear-impact guard. Arm shall move vertically, automatically adjusting to varying height of truck due to loading and unloading operations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**DLM; Systems, LLC**]
e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**McGuire; Systems, LLC**]
g. [**Nordock Inc.**]
h. [**NOVA Technology International, L.L.C.**]
i. [**Pentalift Equipment Corporation**]
j. [**Pioneer Dock Equipment**]
k. [**Poweramp; System, LLC**]
l. [**Rite-Hite Holding Corporation**]
m. [**Rotary Products Inc**]
n. [**Serco; Entrematic; ASSA ABLOY**]
o. [**Vestil Manufacturing Company**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.3.

D. Rated Capacity: Capable of supporting total gross load of [**30,000 (13 608)**][**32,000 (14 515)**] **lb (kg)** without permanent deflection or distortion.

E. Operating Range: Capable of restraining rear-impact guards within a range from:

1. Vertical Range: Minimum of [**7 inches (178 mm)**][**8 inches (203 mm)**][**9 inches (229 mm)**][**11 inches (279 mm)**][**dimension indicated on Drawings**] to maximum of [**28 inches (711 mm)**][**30 inches (762 mm)**][**34 inches (864 mm)**][**dimension indicated on Drawings**] above driveway.
2. Horizontal Range: Zero to [**10 inches (254 mm)**][**12 inches (305 mm)**][**15 inches (381 mm)**][**dimension indicated on Drawings**] in front of dock bumpers.

F. Power Operating System: Manufacturer's standard electromechanical or hydraulic unit.

1. Remote-Control Station: Single-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 12**] box. Restraint is engaged by depressing and holding button; restraint is released by releasing button.
2. Interlock: Leveler does not operate while truck restraint is not engaged.

G. Mechanical Operating System: Restraint operates by use of a lifting rod or hook to raise engagement device.

H. Rear-Impact-Guard Sensor: Detects presence of rear-impact guard[**and automatically returns to stored position if rear-impact guard is not engaged**].

I. Caution Signs: Exterior, surface mounted; designed to inform both dock attendant and truck driver; with sign copy as follows. Provide one sign at each truck-restraint location.

1. Sign Copy in Forward and Reverse Text: [**Manufacturer's standard text permitting truck movement with green light**].
2. Interior Sign Copy: [**Manufacturer's standard text permitting truck movement with green light**].

J. Light Communication System: Red and green illuminated signal-light sets, with lens approximately **4 inches (102 mm)** in diameter, designed to indicate status to both dock attendant and truck driver. Equip system with steel control panel located at interior of dock that [**includes illuminated lights**

indicating][**indicates**] status of exterior signal lights. Provide signal-light set and control panel at each location indicated for light communication system. Enclose exterior signal-light sets in steel or plastic housing with sunshade.

1. Manual Operation: System is activated by push button or switch located on [**interior**][**truck-restraint**] control panel.
2. Automatic Operation:

    a. System is activated automatically by [**limit switch**][**photoelectric sensor**][**magnetic switch**] mounted on overhead door track. Provide on-off switch located on [**light communication system**][**truck-restraint**] control panel.
    b. System is activated automatically when device engages rear-impact guard. Provide on-off switch located on truck-restraint control panel.

3. Mounting: [**Wall**][**Driveway**][**Pit**][**Pedestal**].

    a. Pedestal: **4 by 4 inches (102 by 102 mm) post with base plate and face plate for mounting light communication system,)60 inches (1524 mm) high.)**

        1) Finish: [**Manufacturer's standard baked-on factory finish in yellow or orange**][**Hot-dip galvanized**].

K. Alarm: [**Audible**][**and**][**visual**] system indicating that rear-impact guard is not engaged, with manual reset.

L. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

M. Truck-Restraint Finish: [**Manufacturer's standard electrodeposited zinc coating**][**Hot-dip galvanized**].

N. Accessories: [**Interlock to dock leveler**][**Key switch**].

2.8 LIGHT COMMUNICATION SYSTEMS

A. Light Communication Systems: Communication system consisting of signal-light sets, caution signs, alarms, and controls for each location indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Beacon Industries, Inc**]
    b. [**Kelley; Entrematic; ASSA ABLOY**]
    c. [**Nordock Inc.**]
    d. [**Rite-Hite Holding Corporation**]
    e. [**Serco; Entrematic; ASSA ABLOY**]

f. [**Vestil Manufacturing Company**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Caution Signs: Surface mounted; designed to inform both dock attendant and truck driver; with sign copy as follows:

1. Exterior Sign Copy in Forward and Reverse Text: [**Manufacturer's standard text permitting truck movement with green light**].
2. Interior Sign Copy: [**Manufacturer's standard text permitting truck movement with green light**].
3. Mounting: [**Wall**][**Pedestal**]

D. Signal-Light Sets: Red and green illuminated signal-light sets, with lens approximately **4 inches (102 mm)** in diameter, designed to indicate status to both dock attendant and truck driver. Equip system with steel control panel that [**includes illuminated lights indicating**][**indicates**] status of exterior signal lights; locate control panel at interior of dock. Provide signal-light set and control panel at each location indicated for light communication system. Enclose signal lights in steel or plastic housing, with exterior signal-light sets equipped with sunshade.

1. Manual Operation: Lights are activated by push button or switch located on [**interior signal-light enclosure**][**control panel**].
2. Automatic Operation: Lights are activated automatically by [**limit switch**][**photoelectric sensor**][**magnetic switch**] mounted on overhead door track. Provide on-off switch located on control panel.
3. Mounting: [**Wall**][**Pedestal**]

E. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.9 FINISH REQUIREMENTS

A. Finish loading dock equipment after assembly and testing.

B. Hot-Dip Galvanizing: Comply with the following:

1. ASTM A123/A123M for iron and steel loading dock equipment.
2. ASTM A153/A153M or ASTM F2329/F2329M for iron and steel hardware for loading dock equipment.

C. Spray Zinc Metallizing: ASTM B833.

D. Electrodeposited Zinc Coatings: ASTM B633.

E. Steel Prime Paint Finish: Clean, pretreat, and apply manufacturer's standard primer.

F. Baked-on Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

1. Color: [**Manufacturer's standard**][**Match Architect's sample**], as directed by the Owner.
2. Toe Guards: Paint to comply with ANSI Z535.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical systems for loading dock equipment to verify actual locations of connections before equipment installation.

C. Examine walls and floors of pits for suitable conditions where recessed loading dock equipment is to be installed. Pits shall be plumb and square and properly sloped for drainage from back to front of loading dock.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Set curb angles in concrete edges of dock-leveler recessed pits with tops flush with loading platform. Fit exposed connections together to form hairline joints.

B. Set curb angles in concrete edges of truck-leveler recessed pits with tops flush with driveway. Fit exposed connections together to form hairline joints.

C. Place self-forming pan system for [**recessed dock**][**edge-of-dock**] levelers in proper relation to loading platform before pouring concrete.

D. Clean recessed pits of debris.

3.3 INSTALLATION, GENERAL

A. Install loading dock equipment as required for a complete installation.

1. Rough-in electrical connections.

3.4 INSTALLATION OF RECESSED LOADING DOCK LEVELERS

A. Attach dock levelers securely to loading dock platform, flush with adjacent loading dock surfaces and square to recessed pit.

3.5 INSTALLATION OF EDGE-OF-DOCK LOADING DOCK LEVELERS

A. Attach dock levelers to loading dock platform in a manner that complies with requirements indicated for arrangement and position relative to top of platform.

1. Weld anchor holes in contact with continuous embedded loading dock edge channel. Weld or bolt bumper blocks to face of loading dock.

3.6 INSTALLATION OF TOP-OF-DOCK LOADING DOCK LEVELERS

A. Attach dock levelers to loading dock platform in a manner that complies with requirements indicated for arrangement and position relative to top of platform.

1. Weld anchor holes in contact with continuous embedded loading dock edge channel. Weld or bolt bumper blocks to face of loading dock.

3.7 INSTALLATION OF TRUCK LEVELERS

A. Attach truck levelers securely to driveway construction with expansion anchors and bolts.

3.8 INSTALLATION OF STATIONARY LOADING DOCK LIFTS

A. Attach dock lifts securely to [**loading platform**][**floor of recessed pit**][**surface of driveway**].

3.9 INSTALLATION OF TRUCK RESTRAINTS

A. Attach truck restraints in a manner that complies with requirements for arrangement and height required for device to engage vehicle rear-impact guard.[**Interconnect control panel and signals with dock leveler.**]

1. Wall-Mounted Units: [**Weld**][**Anchor**]

a. Weld truck restraints to steel [**curb angle**][**edge channel**][**mounting plate**] embedded in loading dock edge.
b. Anchor truck restraints to face of loading dock with expansion anchors and bolts.

2. Driveway-Mounted Units: Anchor truck restraints to driveway with expansion anchors and bolts.
3. Pit-Mounted Units: Anchor truck restraints to concrete pit with expansion anchors and bolts.

3.10 ADJUSTING

A. Adjust loading dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.

B. Test dock levelers for vertical travel and adjust to maintain operating range indicated.

C. After completing installation of exposed, factory-finished loading dock equipment, inspect exposed finishes and repair damaged finishes.

3.11 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service shall include [**12**] months' full maintenance by skilled employees of loading dock equipment Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and

adjusting as required for proper loading dock equipment operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain loading dock equipment.

END OF SECTION 11 13 19 00

Task	Specification	Specification Description
11 13 19 13	11 13 19 00	Stationary Loading Dock Equipment
11 13 19 23	11 13 19 00	Stationary Loading Dock Equipment
11 13 19 26	11 13 19 00	Stationary Loading Dock Equipment
11 13 19 33	11 13 19 00	Stationary Loading Dock Equipment

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SECTION 11 13 23 00 - PORTABLE DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable loading dock lifts (scissors lifts).

B. Related Requirements:

1. Section 111319 "Stationary Loading Dock Equipment" for stationary dock lifts (scissor lifts).

1.2 DEFINITIONS

A. Operating Range: Maximum amount of travel above and below the loading dock level.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of portable dock equipment.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For portable dock equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For portable dock equipment, to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 PORTABLE LOADING DOCK LIFTS (SCISSOR LIFTS)

A. Dock Lifts: Portable, scissors-type, single-leg, hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Lifts, Inc**]
b. [**Autoquip Corporation**]
c. [**Beacon Industries, Inc**]
d. [**Blue Giant Equipment Corporation**]
e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**Pentalift Equipment Corporation**]
g. [**Presto Lifts Inc.**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: MH 29.1.

D. Rated Capacity: Lifting capacity of not less than [**8000 lb (3629 kg)**][**load indicated on Drawings**] and with axle loads of [**6500 lb (2948 kg) at ends and 5000 lb (2268 kg) at sides**][**magnitudes indicated on Drawings**].

E. Platform: [**Nonskid, safety-tread**][**Smooth-surface**] heavy[**hot-dip galvanized-**] steel deck plate.

1. Platform Size: [**72 inches (1829 mm) wide by 72 inches (1829 mm) long**][**72 inches (1829 mm) wideby 96 inches (2438 mm) long**][**72 inches (1829 mm) wideby 120 inches (3048 mm) long**][**As indicated on Drawings**].
2. Platform Guarding: [**Bevel toe guards**][**Toe sensor**][**Indicator bar**][**Skirts**][**Enclosure**] to comply with requirements in MH 29.1.
3. [**Removable**][**Fixed**] Guard Rails: Provide [**steel**][**hot-dip galvanized-steel**][**aluminum**] guard rails on two sides of platform with a single, removable chain across each end. Provide guard rails not less than **39 inches (991 mm)** high with midrail and **4-inch- (102-mm-)** high, kick plate at bottom.[**Mount rail sockets flush with platform surface.**]

F. Bridge: [**Nonskid, safety-tread steel**][**Nonskid, safety-tread hot-dip galvanized-steel**][**High-tensile**

aluminum] plate.

1. Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform. Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.
2. Size: [**18 inches (457 mm) long by 60 inches (1524 mm) wide**][**18 inches (457 mm) long by 72 inches (1829 mm) wide**][**As indicated on Drawings**].
3. Locations: [**Ends**][**Sides**][**As indicated on Drawings**].

G. Function: Dock lifts shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel and Travel Speed: As indicated on Drawings.
2. Vertical Travel: Maximum of [**60 (1524)**] **inches (mm)** from a lowered height of [**12 (305)**] **inches (mm)** for a total raised height of [**72 (1829)**]**inches (mm)**.
3. Travel Speed: Nominal raising speed of [**8 (0.04)**][**10 (0.05)**][**12 (0.06)**]**fpm (m/s)**.
4. Hinged Throw-over Bridge Operation: [**Manual**][**Spring assist**][**Manual-assist bridge winch**][**Automatic powered**].

H. Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.

1. Power Unit: Consisting of continuous-duty motor, high-pressure gear pump, valve manifold, oil-line filters, and oil reservoir.

    a. Equip manifold with relief valve, check valve, pressure-compensated flow-control valve, and solenoid valve and with provisions for lowering lift manually if power fails.
    b. Equip reservoir, valve manifold, and pressure line with oil-line filters.

2. Cylinders: Equip lift with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.

    a. Rate of Descent Protection: Pressure-compensated flow control or hydraulic velocity fuse to limit down speed for each cylinder.

3. Remote-Control Station: Multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, [**Type 12**] box.

    a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.

I. Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.

1. Scissors Mechanism: Fabricate leg members from heavy,[**hot-dip galvanized**] steel-formed tube or plate members to provide maximum strength and rigidity.
2. Scissors Configuration: [**Single leg**][**Multiple width**][**Multiple length**].
3. Bearings: Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.
4. Maintenance Leg: Removable, safety maintenance leg or hinged, safety maintenance bars.

J. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.

2.2 FINISH REQUIREMENTS

A. Baked-on Factory Finish: Provide unless otherwise indicated. Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat in manufacturer's standard color.

1. Toe Guards: Paint to comply with ANSI Z535.1.

B. Hot-Dip Galvanizing: Comply with the following:

1. ASTM A123/A123M for iron and steel portable dock equipment.
2. ASTM A153/A153M or ASTM F2329/F2329M for iron and steel hardware for portable dock equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical systems for portable dock equipment to verify actual locations of connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install portable dock equipment as required for a complete installation.

3.3 ADJUSTING

A. Adjust portable dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.

B. Test lifts for vertical travel and adjust to maintain operating range indicated.

C. After completing installation of exposed, factory-finished portable dock equipment, inspect exposed finishes and repair damaged finishes.

3.4 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months'

full maintenance by [**skilled employees of portable dock equipment Installer**][**manufacturer's authorized service representative**]. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper portable dock equipment operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain portable dock equipment.

END OF SECTION 11 13 23 00

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Task	Specification	Specification Description
11 13 23 23	11 13 23 00	Portable Dock Equipment

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SECTION 11 82 26 00 - FACILITY WASTE COMPACTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Facility waste compactors.

B. Related Requirements:

1. Section 113013 "Residential Appliances" for residential trash compactors.
2. Section 114000 "Foodservice Equipment" for food-waste shredding, pulping, grinding, and compacting machines in foodservice facilities.
3. Section 149182 "Trash Chutes" for waste chutes and diverters servicing waste compactors.
4. Section 211000 "Water-Based Fire-Suppression Systems" for building fire sprinklers and piping connections to automatic sprinkler in hopper of each chute-fed compactor.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss electrical, plumbing, and sprinkler roughing-in; equipment bases; and other preparatory work specified elsewhere.
2. Review coordination of chute[**and diverter**] locations with waste compactors.
3. Review sanitary requirements for water bibs, floor drains, and grease traps if required for Project to reduce decomposition and odors.
4. Review haul routes of waste to the compactor, route of hauler's equipment, and protections along these routes that are specified elsewhere.
5. Review required testing, inspection, and certification procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties and accessories, and finishes.

B. Shop Drawings: For each waste compactor and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Dimension chute[**and diverter**] locations that interface with waste compactors.
4. Include location and installation details of automatic sprinkler in hopper of each chute-fed compactor.
5. Indicate equipment access points and required space for equipment service and operation.

6. Include setting drawings, templates, and instructions for installing anchor bolts and other anchorages.
7. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of waste compactor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For waste compactors to include in operation and maintenance manuals.

B. Continuing Maintenance Proposal: From Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Maintenance Proximity: Not more than [**one**][**two**] hour(s') normal travel time from Installer's place of business to Project site.

PART 2 - PRODUCTS

2.1 FACILITY WASTE COMPACTORS

A. Waste Compactor: Manufacturer's standard [stationary-horizontal][self-contained horizontal][compactor-container (combination-container)][vertical][pivoting-ram] -type stationary compactor, complying with requirements[liquidtight]; and with components, options, and accessories needed to provide a complete, functional system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Compactors, Inc.**]
b. [**Cram-A-Lot; J.V. Manufacturing, Inc.**]
c. [**Harmony Enterprises, Inc.**]
d. [**Marathon Equipment Company; a Dover company**]
e. [**Precision Machinery Systems LLC**]
f. [**PTR Baler & Compactor Company**]
g. [**Rudco Products, Inc.**]

h. [**Sebright Products, Inc.**]
i. [**SP Industries, Inc**]
j. [**Wastequip, LLC**]
k. [**Western Chutes; Buchanan Company, Inc.**]
l. [**Wilkinson Hi-Rise, LLC**]

2. Source Limitations: Obtain from single source from single manufacturer.
3. Waste-Compactor Standards: ANSI Z245.21[**including appendices**] and NFPA 82.
4. Waste-Container Standards: ANSI Z245.30 and ANSI Z245.60.
5. Rated Size (Volume): Minimum [**0.14 cu. yd. (0.11 cu. m)**][**1.00 cu. yd. (0.77 cu. m)**][**1.50 cu. yd. (1.15 cu. m)**][**2.00 cu. yd. (1.53 cu. m)**][**3.50 cu. yd. (2.68 cu. m)**][**5.00 cu. yd. (3.82 cu. m)**][**7.50 cu. yd. (5.73 cu. m)**][**10.00 cu. yd. (7.65 cu. m)**].
6. Clear Top Opening (Length by Width): Minimum [**20 by 28 inches (508 by 711 mm)**][**24 by 36 inches (610 by 914 mm)**][**30 by 48 inches (762 by 1219 mm)**][**60 by 48 inches (1524 by 1219 mm)**][**108 by 72 inches (2743 by 1829 mm)**].
7. Cycle Time: Maximum [**30**][**40**][**50**][**60**][**70**] seconds.
8. Normal/Maximum Resultant Ram Forces: [**20,000/22,000 lbf (89/98 kN)**][**36,000/40,000 lbf (160/178 kN)**][**70,000/80,000 lbf (311/356 kN)**][**125,000/150,000 lbf (556/667 kN)**].
9. Normal/Maximum System Pressures: [**1600/1800 psi (11.0/12.4 MPa)**][**2000/2400 psi (13.8/16.5 MPa)**][**2500/2800 psi (17.2/19.3 MPa)**].
10. Scale Weight: Maximum [**2500 lb (1134 kg)**][**6000 lb (2722 kg)**][**12,000 lb (5443 kg)**][**20,000 lb (9072 kg)**].
11. Electrical Characteristics:

    a. Horsepower: [**3**][**10**][**15**][**20**][**30**][**50**] hp.
    b. Voltage: [**115 V ac single phase, 60 Hertz**][**230 V ac, single phase, 60 Hertz**][**208 V ac, three phase, 60 Hertz**][**230 V ac, three phase, 60 Hertz**][**460 V ac three phase, 60 Hertz**].

12. Finish: [**Manufacturer's standard**][**Manufacturer's standard primer for field painting**].

    a. Color: [**White**][**Black**][**Gray**][**Dark green**][**Yellow**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

13. Deodorizing Device: [**Manufacturer's standard**].

B. Number of Extra Storage Containers: [**One**][**Two**].

2.2 FABRICATION

A. Fabricate waste compactors with smooth, eased, exposed edges to prevent injury to persons in vicinity of the equipment.

B. Fabricate containers, hoppers, compaction chambers, unit bodies, and similar components of steel with welded joints. Reinforce with steel members sized and spaced to withstand impacts and pressures of normal operations and to prevent deformation.

C. Fabricate equipment with replaceable parts at points of normal wear.

D. Fabricate liquidtight compactor baffles to stop liquid from leaking out.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, clearances, service rough-ins, and other conditions affecting performance of the Work.

B. Examine walls, floors, and chutes for suitable conditions where each waste compactor will be installed.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FACILITY WASTE COMPACTORS

A. Install each waste compactor according to manufacturer's written instructions, ANSI Z245.2, and ANSI Z245.21[including appendices].

B. Install automatic sprinkler in hopper of each chute-fed compactor according to NFPA 82.

C. Set waste compactors level, plumb, properly aligned, and securely in place. Anchor as required for secure operation.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to[**ANSI Z245.21, Appendix D, "Tests for Evaluation of Equipment and Performance," and**] manufacturer's written instructions.
2. Test and adjust controls, alarms, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Verify unrestricted access to each firefighting access door or hose connection required by ANSI Z245.21 and NFPA 82 for compactor container(s).
4. Verify correct locations, color coding, and legibility of caution, warning, and danger markings.
5. Certify compliance with test parameters.

B. A waste compactor will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, initial maintenance service shall include [**12**] months' full maintenance by skilled employees of waste-compactor Installer. Include [**monthly**] preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper waste-compactor operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain waste compactors according to manufacturer's written instructions and ANSI Z245.2.

END OF SECTION 11 82 26 00

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SECTION 11 97 26 00 - DETENTION GUN LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pistol lockers.
2. Tilt-out pistol lockers.

B. Related Requirements:

1. Section 119814 "Detention Door Hardware" for cylinders and keying for detention gun lockers.
2. Section 125500 "Detention Furniture" for detention furniture.

1.2 COORDINATION

A. Detention Specialist: Coordinate with Section 013513.16 "Special Project Procedures for Detention Facilities" for requirements of this Section that are to be performed by a Detention Specialist or other entity.

B. Coordinate installation of anchorages for detention gun lockers. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in adjacent construction. Deliver such items to Project site in time for installation.

C. Coordinate size and location of recesses in wall construction to receive recessed detention gun lockers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for detention gun lockers.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: For detention gun lockers.

1. Include plans, elevations, sections, and attachment details.
2. Indicate locations, dimensions, and profiles of wall and floor reinforcements.

3. Indicate locations and installation details of built-in anchors.
4. Show elevations and indicate dimensions of detention gun lockers, preparations for receiving anchors, and locations of anchorage.
5. Show details of attachment of detention gun lockers to built-in anchors.

D. Samples for Initial Selection: For detention gun lockers with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Examination reports documenting inspections of substrates, areas, and conditions.

C. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

D. Field quality-control reports documenting inspections of installed products.

1. Field quality-control certification signed by Contractor[**and Detention Specialist**].

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify openings for recessed detention gun lockers by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.2 PISTOL LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Jail Products L.L.C.**]
2. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
3. [**Detention Device Systems (DDS); DDS Group**]

4. [**Maximum Security Products Corp**]
5. [**PSI LLC**]
6. [**Southern Folger Detention Equipment Company**]
7. [**Sweeper Metal Fabricators Corp**]
8. [**Tiffin Metal Products Co.**]
9. [**Willo Products Company, Inc.**]

B. Cabinet: Minimum **20 inches (508 mm)** wide by **15 inches (381 mm)** high by **10 inches (254 mm)** deep; formed from [**0.134-inch (3.42-mm) nominal-thickness steel sheet**][**0.141-inch (3.57-mm) nominal-thickness stainless steel sheet**]. Line each compartment with mothproofed felt or nonabsorbing, closed-cell padding.

1. Compartments: [**Six**].

C. Doors: Formed from [**3/16-inch- (4.8-mm-) thick steel plate**][**0.180-inch (4.55-mm) nominal-thickness steel sheet**][**same material as cabinet**], supported by heavy-duty continuous bottom hinge.

D. Locks: [**Snap**][**Cylinder**] type, keyed differently[**and master keyed**]; provide one lock for each compartment.

1. Lock Preparation: Prepare door panel to accept cylinder specified in Section 119814 "Detention Door Hardware."

E. Mounting: [**Surface**][**Recessed, with mounting flange formed from same material as body**].

F. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.

G. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) Run grain of directional finishes with long dimension of each piece.
2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3) Directional Satin Finish: No. 3.

2.3 TILT-OUT PISTOL LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Jail Products L.L.C.**]
2. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
3. [**Detention Device Systems (DDS); DDS Group**]
4. [**Maximum Security Products Corp**]
5. [**Norix Group, Inc.**]
6. [**PSI LLC**]
7. [**Southern Folger Detention Equipment Company**]
8. [**Sweeper Metal Fabricators Corp**]
9. [**Willo Products Company, Inc.**]

B. Cabinet: Minimum **39 inches (991 mm)** wide by **15 inches (381 mm)** high by **6 inches (152 mm)** deep; formed from [**0.134-inch (3.42-mm) nominal-thickness steel sheet**][**0.141-inch (3.57-mm) nominal-thickness stainless steel sheet**].

1. Compartments: [**Six**].

C. Tilt-Out Compartments: Doors formed from [**3/16-inch- (4.8-mm-) thick steel plate**][**0.180-inch (4.55-mm) nominal-thickness steel sheet**][**same material as cabinet**], supported by heavy-duty continuous bottom hinge, with attached tilt-out compartment with formed metal sides. Line each compartment with mothproofed felt or nonabsorbing, closed-cell padding.

D. Locks: [**Snap**][**Cylinder**] type, keyed differently[**and master keyed**]; provide one lock for each compartment.

1. Lock Preparation: Prepare door panel to accept cylinder specified in Section 119814 "Detention Door Hardware."

E. Mounting: [**Surface**][**Recessed, with mounting flange formed from same material as body**].

F. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.

G. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish, consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) Run grain of directional finishes with long dimension of each piece.
2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3) Directional Satin Finish: No. 3.

2.4 FABRICATION

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of detention gun lockers with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Form and grind edges and corners to be free of sharp edges or rough areas.

E. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

F. Weld corners and seams continuously to comply with referenced AWS standard and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish exposed welds and surfaces smooth and blended at exposed connections, so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

G. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention gun lockers rigidly in place and to support expected loads. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.

H. Cut, reinforce, drill, and tap detention gun lockers as indicated to receive hardware, fasteners, and similar items.

I. Form exposed work true to line and level with accurate angles, surfaces, and straight sharp edges.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where

possible. Locate joints where least conspicuous.

2.5 ACCESSORIES

A. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.

B. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to [**4**] times the load imposed, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified testing agency; of type indicated below.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed; hot-dip galvanized in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

C. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum **3/16 inch (4.8 mm)** thick; with minimum **1/2-inch- (12.7-mm-)** diameter, headed studs welded to back of plate.

D. Proprietary Built-in Masonry Anchors: Fabricated from [0.134-inch (3.42-mm) nominal-thickness steel sheet][1/4-inch (6-mm) nominal-thickness steel plate][1/2-inch (12.7-mm) nominal-thickness steel plate] into [6-inch- (152-mm-)][8-inch- (203-mm-)] deep blocks matching size of concrete masonry units[with weld nuts attached on inside to receive field-bolted attachments].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**M/BED Block Systems, LLC.**]
b. [**Peterson Detention Inc. (PDI)**]

2. Finish: [**Factory primed for field painting for anchors with field-welded attachments**][**Polyester powder coat for anchors with bolted attachments**][**Epoxy paint for anchors with bolted attachments**].

E. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of detention gun lockers.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of detention gun lockers before detention gun locker installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of detention gun lockers.

D. Inspect built-in and cast-in anchor installations, before installing detention gun lockers, to verify that

anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

E. Verify locations of detention gun lockers with those indicated on Shop Drawings.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention gun lockers to in-place construction. Include threaded fasteners for [**concrete**][**and**][**masonry**] inserts and other connectors.

B. Cutting, Fitting, and Placement: Obtain manufacturer's written approval for cutting, drilling, and fitting required for installing detention gun lockers. Set detention gun lockers accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into [concrete][masonry] or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

E. Adjust doors and latches of detention gun lockers to operate easily without binding. Verify that integral locking devices operate properly.

F. Assemble detention gun lockers requiring field assembly with security fasteners with no exposed fasteners on exposed faces and frames.

3.3 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

B. Remove and replace detention work if inspections indicate that work does not comply with specified requirements. Remove malfunctioning units; replace with new units.

C. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

D. Prepare field quality-control certification[endorsed by Detention Specialist,] that states installed products and their installation comply with requirements in the Contract Documents.

END OF SECTION 11 97 26 00

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SECTION 11 97 26 00A - DETENTION FURNITURE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Detention bunks.
2. Detention mattresses.
3. Detention desks.
4. Detention tables.
5. Detention seating.

B. Related Requirements:

1. Section 102813.63 "Detention Toilet Accessories" for detention toilet and bath accessories.
2. Section 111916 "Detention Gun Lockers" for detention gun lockers.
3. Section 119814 "Detention Door Hardware" for security key cabinets.

1.2 COORDINATION

A. Detention Specialist: Coordinate with Section 013513.16 "Special Project Procedures for Detention Facilities" for requirements of this Section that are to be performed by a Detention Specialist or other entity.

B. Coordinate installation of anchorages for detention furniture. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in adjacent construction. Deliver such items to Project site in time for installation.

C. Coordinate size and location of recesses in wall construction to receive detention furniture.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for detention furniture.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For sealants, indicating VOC content.

3. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For detention furniture.

1. Include plans, elevations, sections, and attachment details.
2. Indicate locations, dimensions, and profiles of wall and floor reinforcements.
3. Indicate locations and installation details of built-in anchors.
4. Show elevations of detention furniture and indicate dimensions of furniture, preparations for receiving anchors, and locations of anchorage.
5. Show details of attachment of detention furniture to built-in anchors.

D. Samples for Initial Selection: For detention furniture with factory-applied color finishes.

E. Samples for Verification: For each type of detention furniture indicated.

1. Furniture: Full-size units. Approved Samples may become part of the completed Work.
2. Detention Mattresses: Not less than **6 inches (152 mm)** square by full depth, including core and cover fabric.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Examination reports, documenting inspections of substrates, areas, and conditions.

C. Anchor inspection reports, documenting inspections of built-in and cast-in anchors.

D. Field quality-control reports, documenting inspections of installed products.

1. Field quality-control certification, signed by Contractor[**and Detention Specialist**].

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For detention mattresses to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Security Fasteners: Furnish not less than one box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.
2. Tools: Provide [**two**] sets of tools for installing and removing security fasteners.

1.8 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

B. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup of typical detention cell with furniture as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Detention Mattresses: Deliver wrapped to provide protection during transit and Project-site storage. Protect from contact with moisture.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify openings for recessed detention furniture by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 DETENTION BUNKS

A. Freestanding Single Bunks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Jail Products L.L.C.**]
b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
c. [**Detention Device Systems (DDS); DDS Group**]
d. [**Maximum Security Products Corp**]
e. [**Norix Group, Inc.**]
f. [**PSI LLC**]
g. [**Willo Products Company, Inc.**]

2. Bunk Pan: Formed from [0.134-inch (3.42-mm)][0.105-inch (2.66-mm)] nominal-thickness steel sheet[perforated with at least six holes].

a. Size: Minimum **27 inches (689 mm)** wide by **76 inches (1930 mm)** long with bunk pan **14 inches (356 mm)** above floor.
b. Edges: Turn up edges of [**back and sides and turn down edge of front**][**back, sides, and front**], with minimum **2-inch (51-mm)** flanges.

3. Drawer: Minimum **21 inches (533 mm)** wide by **24 inches (610 mm)** deep by **5 inches (127 mm)** high, with [**full-width integral pull formed from steel sheet**][**solid-steel bar pull**]; formed from **0.134-inch (3.42-mm)** nominal-thickness steel sheet.
4. Legs and Frames: Formed from **2-by-2-by-3/16-inch (51-by-51-by-4.8-mm)** steel angle welded at connections to each other and to bunk pan; provide four legs for each bunk.

5. Mounting Plates: Formed from **1/4-inch- (6-mm-)** thick, steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.

B. Freestanding Double Bunks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Jail Products L.L.C.**]
   b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
   c. [**Detention Device Systems (DDS); DDS Group**]
   d. [**Maximum Security Products Corp**]
   e. [**Norix Group, Inc.**]
   f. [**PSI LLC**]
   g. [**Sweeper Metal Fabricators Corp**]
   h. [**Willo Products Company, Inc.**]

2. Bunk Pan: Formed from [0.134-inch (3.42-mm)][0.105-inch (2.66-mm)] nominal-thickness steel sheet[each pan perforated with at least six holes].

   a. Size: Minimum **27 inches (689 mm)** wide by **76 inches (1930 mm)** long with lower bunk pan **14 inches (356 mm)** above floor and upper bunk pan at least **49 inches (1245 mm)** above floor.
   b. Upper Bunk Edges: Turn up edges of back and sides and turn down edge of front, with minimum **2-inch (51-mm)** flanges.
   c. Lower Bunk Edges: Turn up edges of [**back and sides and turn down edge of front**][**back, sides, and front**], with minimum **2-inch (51-mm)** flanges.

3. Drawers: Two; minimum **21 inches (533 mm)** wide by **24 inches (610 mm)** deep by **5 inches (127 mm)** high, with [**full-width integral pull formed from steel sheet**][**solid-steel bar pull**]; formed from **0.134-inch (3.42-mm)** nominal-thickness steel sheet.
4. Legs and Frames: Formed from **2-by-2-by-3/16-inch (51-by-51-by-4.8-mm)** steel angle welded at connections to each other and to bunk pan; provide four legs for each bunk.
5. Mounting Plates: Formed from **1/4-inch- (6-mm-)** thick, steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.
6. Assembly: [**Factory assembled**][**Knocked down for field assembly**].

C. Wall-Mounted Bunks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Jail Products L.L.C.**]
   b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
   c. [**Detention Device Systems (DDS); DDS Group**]
   d. [**Maximum Security Products Corp**]
   e. [**Norix Group, Inc.**]
   f. [**PSI LLC**]
   g. [**Sweeper Metal Fabricators Corp**]
   h. [**Willo Products Company, Inc.**]

2. Bunk Pan: Formed from [0.134-inch (3.42-mm)][0.105-inch (2.66-mm)] nominal-thickness steel sheet[perforated with at least six holes].

   a. Size: Minimum **27 inches (689 mm)** wide by **76 inches (1930 mm)** long with bunk pan **2 inches (51 mm)** from wall.
   b. Edges: Turn up edges of [**back and sides and turn down edge of front**][**back, sides, and front**], with minimum **2-inch (51-mm)** flanges.

3. Drawer: Minimum **21 inches (533 mm)** wide by **24 inches (610 mm)** deep by **5 inches (127 mm)** high, with [**full-width integral pull formed from steel sheet**][**solid-steel bar pull**]; formed from **0.134-inch (3.42-mm)** nominal-thickness steel sheet.
4. Combination End Panel/Mounting Plate: Formed from **3/16-inch- (0.048-mm-)** thick steel sheet welded at connections to bunk pan, with **2-inch (51-mm)** flange for wall mounting; provide two end panel/mounting plates for each bunk.

D. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.

E. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.2 DETENTION MATTRESSES

A. Detention Mattresses: Comply with 16 CFR 1633 and California Technical Bulletin 121 as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
   b. [**Chestnut Ridge Foam, Inc**]
   c. [**Derby Industries**]
   d. [**Norix Group, Inc.**]
   e. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]

B. Core: [**Fire-resistive solid foam**][**Fire-resistive densified polyester**][**Cotton, with 10 percent boric acid treatment, tufted to nylon netting to retain shape**].

C. Cover Fabric: Vinyl bonded to nylon scrim; with a minimum total weight of 10 oz./sq. yd. (339 g/sq. m).

Fabricate cover using [all sealed-seam construction with radio-frequency welded inverted seams][four-corner box construction with seams facing inside of detention mattress except end closing seam located at foot of mattress; sew with nylon thread in a double-lock stitch][with integral pillow].

1. Color: [**Clear**][**Manufacturer's standard**].

D. Thickness: [**4 inches (102 mm)**][**6 inches (152 mm)**].

2.3 DETENTION DESKS

A. Single-Seat, Floor-Mounted Desks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Jail Products L.L.C.**]
   b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
   c. [**Maximum Security Products Corp**]
   d. [**PSI LLC**]
   e. [**Sweeper Metal Fabricators Corp**]
   f. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]
   g. [**Willo Products Company, Inc.**]

2. Desk Top: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.

   a. Size: Minimum **36 inches (914 mm)** wide by **15-1/2 inches (381 mm)** deep.

3. Pedestal: Provide two storage shelves with sides and shelves formed from **0.134-inch (3.42-mm)** nominal-thickness steel.
4. Legs: Formed from **1-1/2-inch-square by 3/16-inch- (38-mm-square by 4.8-mm-)** thick steel tubing welded to desk top and mounting plate for an overall desk height of not less than **30 inches (762 mm)**.
5. Seat: **12-inch (305-mm)** diameter, formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.075-inch (1.90-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet; reinforced with **0.134-inch (3.42-mm)** nominal-thickness steel sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.
6. Swivel Seat Support: Formed from **1-by-2-by-0.075-inch (25-by-51-by-1.90-mm)** nominal-thickness steel tubing, **2-inch-OD-by-0.075-inch (51-mm-OD-by-1.90-mm)** nominal-thickness steel tubing, or **3/8-inch- (9.5-mm-)** thick, steel plate bar; with **1/2-inch (12.7-mm)** pivot pin welded to legs.
7. Towel Bar: Formed from **1/4-by-1-1/2-inch (6-by-38-mm)** [**steel**][**stainless steel**] plate, mounted on one side of desk.
8. Mounting Plates: Formed from **1/4-inch- (6-mm-)** thick, steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.

B. Wall-Mounted Desk and Seat:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**American Jail Products L.L.C.**]
b. [**Maximum Security Products Corp**]
c. [**Norix Group, Inc.**]
d. [**Willo Products Company, Inc.**]

2. Desk: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**] sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.

a. Size: Minimum [**12 inches (305 mm) wide by 18 inches (457 mm) deep**][**18 inches (457 mm) wide by 18 inches (457 mm) deep**][**24 inches (610 mm) wide by 18 inches (457 mm) deep**][**30 inches (762 mm) wide by 20 inches (508 mm) deep**].

3. Seat: Minimum **12 inches (305 mm)** wide by [**16 inches (406 mm)**][**18 inches (457 mm)**] deep; formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**] sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.

C. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
5. Steel Tubing: ASTM A513/A513M, Type B unless otherwise indicated; thickness indicated or required by structural loads.

D. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) Run grain of directional finishes with long dimension of each piece.
2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3) Directional Satin Finish: [**No. 3**][**No. 4**].

2.4 DETENTION TABLES

A. Pedestal-Style Table:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Jail Products L.L.C.**]
    b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
    c. [**Detention Device Systems (DDS); DDS Group**]
    d. [**Maximum Security Products Corp**]
    e. [**PSI LLC**]
    f. [**Sweeper Metal Fabricators Corp**]
    g. [**Willo Products Company, Inc.**]

2. Tabletop: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.109-inch- (2.78-mm-) thick, stainless steel**][**0.078-inch- (1.98-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet; reinforced with steel shapes or steel plate, with minimum **1-1/2-inch (38-mm)** flanged edges.

    a. Size: Minimum [**30 inches (762 mm)**][**40 inches (1016 mm)**] wide by length required for capacity by [**30 inches (762 mm)**][**35 inches (889 mm)**] high.
    b. Game Top: Engrave, or otherwise integrally incorporate, checkerboard into tabletop.

3. Seats: **12-inch (305-mm)** diameter, formed from [**0.105-inch (2.66-mm) nominal-thickness steel**][**0.075-inch (1.90-mm) nominal-thickness steel**][**0.078-inch- (1.98-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet; reinforced with **0.134-inch (3.42-mm)** nominal-thickness steel plate, with minimum **1-1/2-inch (38-mm)** flanged edges.
4. Pedestal Supports: Formed from [**3-inch-square by 3/16-inch- (76-mm-square by 4.8-mm-)**][**4-inch-square by 0.134-inch- (102-mm-square by 3.42-mm-)**] thick, steel tubing welded to top and base plate.[**Provide two pedestals for tables with capacity of more than four persons.**]
5. Seat Framing: Formed from [**3-inch-square by 0.134-inch- (76-mm-square by 3.42-mm-)**][**3-by-2-by-3/16-inch- (76-by-51-by-4.8-mm-)**] thick, steel tubing welded to pedestal supports.
6. Base Plate: Minimum **16-inch- (406-mm-)** square, **1/4-inch- (6-mm-)** thick, steel plate punched with four holes for floor anchorage.
7. Capacity: [**Four persons**][**Six persons**][**Eight persons**][**As indicated on Drawings**].

B. Bench-Style Table:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Jail Products L.L.C.**]
    b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
    c. [**Maximum Security Products Corp**]
    d. [**Norix Group, Inc.**]
    e. [**PSI LLC**]
    f. [**Sweeper Metal Fabricators Corp**]
    g. [**Willo Products Company, Inc.**]

2. Tabletop: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.109-inch- (2.78-mm-) thick, stainless steel**] sheet; reinforced with steel channel frame or steel plate, with minimum **1-1/2-inch (38-mm)** flanged edges.

    a. Size: Minimum **24 inches (610 mm)** wide by length required for capacity by [**30 inches**

(762 mm)][35 inches (889 mm)] high.

3. Benches: 12 inches (305 mm) deep by length of tabletop, formed from [0.134-inch (3.42-mm) nominal-thickness steel][0.105-inch (2.66-mm) nominal-thickness steel][0.109-inch- (2.78-mm-) thick, stainless steel][0.062-inch- (1.59-mm-) thick, stainless steel] sheet, with minimum 1-1/2-inch (38-mm) flanged edges.
4. Vertical Supports: Formed from 8-inch (203-mm) hot-rolled steel channels or 0.164-inch- (4.18-mm-) thick, formed-steel channels; braced and welded, with steel base plates punched for floor anchorage.[**Provide three supports for tables with capacity of more than four persons.**]
5. Bench Supports: Formed from 2-by-2-1/2-by-1/4-inch- (51-by-64-by-6-mm-) thick, steel angle or 2-inch-square by 1/4-inch- (51-mm-square by 6-mm-) thick, steel tubing; welded to vertical supports.
6. Floor Anchor: Formed from steel angle punched for floor anchorage.
7. Capacity: [**Four persons**][**Six persons**][**Eight persons**][**As indicated on Drawings**].

C. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
5. Steel Tubing: ASTM A513/A513M, Type B unless otherwise indicated; thickness indicated or required by structural loads.

D. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).

    a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

    a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
    b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

        1) Run grain of directional finishes with long dimension of each piece.
        2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
        3) Directional Satin Finish: [**No. 3**][**No 4**].

2.5 DETENTION SEATING

A. Floor-Mounted Stool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**American Jail Products L.L.C.**]
b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
c. [**Detention Device Systems (DDS); DDS Group**]
d. [**Maximum Security Products Corp**]
e. [**Norix Group, Inc.**]
f. [**PSI LLC**]
g. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]
h. [**Willo Products Company, Inc.**]

2. Seats: Minimum **12-inch (305-mm)** diameter, formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.075-inch (1.90-mm) nominal-thickness steel**][**0.125-inch- (3.18-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet; reinforced with **0.134-inch- (3.42-mm-)** thick steel sheet cut to interior dimension of seat, with minimum **1-1/2-inch (38-mm)** flanged edges.
3. Seat Support: Formed from steel pipe or **2-inch-OD-by-0.075-inch- (51-mm-OD-by-1.90-mm-)** thick, steel tubing welded to seat reinforcement and base plate for an overall stool height of not less than **18 inches (457 mm)**.
4. Base Plate: Minimum **6-by-1/4-inch- (152-by-6-mm-)** thick, [**square**][**round**][**steel**] punched with four holes for floor anchorage.

B. Wall-Mounted Stool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Jail Products L.L.C.**]
b. [**Maximum Security Products Corp**]
c. [**PSI LLC**]
d. [**Willo Products Company, Inc.**]

2. Seat: Minimum **12-inch (305-mm)** diameter, formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.075-inch (1.90-mm) nominal-thickness steel**][**0.125-inch- (3.18-mm-) thick, stainless steel**][**0.078-inch- (1.98-mm-) thick, stainless steel**] sheet; reinforced with **0.134-inch- (3.42-mm-)** thick steel sheet cut to interior dimension of seat, with minimum **1-1/2-inch (38-mm)** flanged edges.
3. Seat Support: Formed from **1-by-2-by-0.075-inch- (25-by-51-by-1.90-mm-)** thick, steel tubing; **2-inch-OD-by-0.075-inch- (51-mm-OD-by-1.90-mm-)** thick, steel tubing; or **3/8-inch- (9.5-mm-)** thick, steel plate bar; welded to seat reinforcement and wall bracket.
4. Swivel Wall Bracket: Minimum **1/2-inch (12.7-mm)** pivot pin, with **3/8-inch- (9.5-mm-)** thick, steel plate [**for welding to embedded steel plate**][**for welding to steel wall**][**punched with four holes for wall anchorage**].

C. Floor-Mounted Bench:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Jail Products L.L.C.**]

b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
c. [**Maximum Security Products Corp**]
d. [**Norix Group, Inc.**]
e. [**PSI LLC**]
f. [**Willo Products Company, Inc.**]

2. Bench Top: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**][**0.109-inch- (2.78-mm-) thick, stainless steel**] sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.

   a. Size: Minimum **12 inches (305 mm)** deep by [**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**] long.

3. Supports: Formed from **0.164-inch- (4.18-mm-)** thick, formed-steel channels or **2-1/2-inch-OD-by-0.0677-inch- (64-mm-OD-by-1.7-mm-)** thick, steel tubing; welded to bench and base plate for an overall bench height of not less than **18 inches (457 mm)**.[**Provide three supports for benches with length of more than 72 inches (1829 mm).**]
4. Handcuff Ring: Formed from **3/8-inch- (9.5-mm-)** diameter, stainless steel rod;welded to [**front**][**back**][**both sides**] of each support.
5. Base Plates: Minimum **8-inch-square by 1/4-inch- (203-mm-square by 6-mm-)** thick, steel plate punched with four holes for floor anchorage.
6. Capacity: [**Four persons**][**Six persons**][**Eight persons**][**As indicated on Drawings**].

D. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
5. Steel Tubing: ASTM A513/A513M, Type B unless otherwise indicated; thickness indicated or required by structural loads.
6. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless another weight is indicated or required by structural loads.

E. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded

foreign matter and leave surfaces chemically clean.

3) Directional Satin Finish: [**No. 3**][**No 4**].

2.6 FABRICATION

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of detention furniture with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Form and grind edges and corners to be free of sharp edges or rough areas.

1. Fabricate detention furniture with no more than **1/32-inch (0.8-mm)** gap between component materials. Weld edges that cannot be crimped to meet tolerance so as to provide a seamless joint with no place for concealment of contraband.

E. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

F. Weld corners and seams continuously to comply with referenced AWS standard and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

G. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention furniture rigidly in place and to support expected loads. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.

H. Cut, reinforce, drill, and tap detention furniture as indicated to receive hardware, security fasteners, and similar items.

I. Form exposed work true to line and level with accurate angles, surfaces, and straight sharp edges.

J. Form exposed connections with hairline joints, flush and smooth using concealed fasteners where possible. Use exposed security fasteners of type indicated or, if not indicated, flat-head (countersunk) security fasteners. Locate joints where least conspicuous.

K. Attach [**drawer slides**][**shelves**] to furniture [**by welding**][**with security fasteners**].

2.7 SECURITY FASTENERS

A. Security Fasteners: Operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific type of fastener. Drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
   b. [**Bryce Fastener Mfg., Inc.**]
   c. [**Safety Socket LLC**]
   d. [**Tamper-Pruf Screws**]

2. Drive-System Type: [**Pinned Torx-Plus**][**Pinned Torx**].
3. Fastener Strength: **120,000 psi (827 MPa)**.
4. Socket Button Head Fasteners:

   a. Heat-treated alloy steel, ASTM F835.
   b. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

5. Socket Flat Countersunk Head Fasteners:

   a. Heat-treated alloy steel, ASTM F835.
   b. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

6. Socket Head Cap Fasteners:

   a. Heat-treated alloy steel, ASTM A574.
   b. Stainless steel, **ASTM F837 (ASTM F837M)**, Group 1 CW.

7. Protective Coatings for Heat-Treated Alloy Steel:

   a. Zinc and clear trivalent chromium where indicated.
   b. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

2.8 SECURITY SEALANTS

A. Polyurethane Security Sealants: Manufacturer's standard, nonsag, tamper-resistant sealant for joints with low movement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Master Builders Solutions**]
   b. [**Pecora Corporation**]

2. Sealant shall have a VOC content of 250 g/L or less.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers."

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Epoxy Security Sealants: Manufacturer's standard, non-sag, tamper-resistant sealant for joints with no movement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    b. [**Master Builders Solutions**]
    c. [**Pecora Corporation**]

2. Sealant shall have a VOC content of 250 g/L or less.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.9 ACCESSORIES

A. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.

B. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining,

without failure, a load equal to [**four**] times the load imposed, as determined by testing per ASTM E488/E488M, conducted by a qualified testing agency; of type indicated below:

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed; hot-dip galvanized per ASTM A153/A153M or ASTM F2329/F2329M.

C. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum **3/16 inch (4.8 mm)** thick; with minimum **1/2-inch- (12.7-mm-)** diameter, headed studs welded to back of plate.

D. Proprietary Built-in Masonry Anchors: Fabricated from [0.134-inch (3.42-mm) nominal-thickness steel sheet][1/4-inch (6-mm) nominal-thickness steel plate][1/2-inch (12.7-mm) nominal-thickness steel plate] into [6-inch- (152-mm-)][8-inch- (203-mm-)] deep blocks matching size of concrete masonry units[with weld nuts attached on inside to receive field-bolted attachments].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**M/BED Block Systems, LLC.**]
   b. [**Peterson Detention Inc. (PDI)**]

2. Finish: [**Factory primed for field painting for anchors with field-welded attachments**][**Polyester powder coat for anchors with bolted attachments**][**Epoxy paint for anchors with bolted attachments**].

E. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of detention furniture.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of detention furniture before detention furniture installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of detention furniture.

D. Inspect built-in and cast-in anchor installations, before installing detention furniture, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

E. Verify locations of detention furniture with those indicated on Shop Drawings.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention furniture to in-place construction. Include threaded fasteners for [**concrete**][**and**][**masonry**] inserts, security fasteners, and other connectors.

B. Cutting, Fitting, and Placement: Obtain manufacturer's written approval for cutting, drilling, and fitting required for installing detention furniture. Set detention furniture accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into [concrete][masonry] or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Fillet Welds:

    a. Minimum size of **1/8 inch by 1-1/2 inches (3 mm by 38 mm)** long, spaced not greater than **12 inches (305 mm)** o.c. Fill spaces between welds with [**polyurethane**][**epoxy**] security sealant where weld is exposed.
    b. Continuous.

F. Assemble detention furniture requiring field assembly with security fasteners with no exposed fasteners on exposed faces and frames.

G. Anchor furniture [**with security fasteners**][**by welding**][**as indicated on Drawings**] to floors and walls at intervals required by expected loads, but not more than **12 inches (305 mm)** o.c.

1. Install anchors through backup reinforcing plates where necessary to avoid metal distortion.
2. Use security fasteners with head styles appropriate for installation requirements, strength, and finish of adjacent materials, except that a maximum of two different sets of tools shall be required to operate security fasteners for Project.[**Provide stainless steel security fasteners in painted materials.**]
3. Weld nuts onto cast-in-place anchors after installation so as to be nonremovable.

H. Apply [**polyurethane**][**epoxy**] security sealant at all exposed gaps between detention furniture and adjacent construction greater than **1/16 inch (1.6 mm)**.

I. Install one detention mattress for each detention bunk.

3.3 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

B. Remove and replace detention work if inspections indicate that work does not comply with specified requirements. Remove malfunctioning units; replace with new units.

C. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

D. Prepare field quality-control certification[**endorsed by Detention Specialist**] that states installed products and their installation comply with requirements in the Contract Documents.

3.4 CLEANING AND PROTECTION

A. Touchup Painting:

1. Immediately after erection, clean bolted connections and abraded areas of shop paint, and paint exposed areas with same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
2. Cleaning and touchup painting of bolted connections and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

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SECTION 13 01 11 11 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation of exterior substrates and application of the following:

1. Primers.
2. Water-based finish coatings.
3. Solvent-based finish coatings.
4. Floor sealers and paints.

B. Related Requirements:

1. [**Section 051200 "Structural Steel Framing"**] [**Section 051213 "Architecturally Exposed Structural Steel Framing"**] for shop priming structural steel substrates.
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
3. Section 055113 "Metal Pan Stairs" for shop priming metal pan stairs.
4. Section 055116 "Metal Floor Plate Stairs" for shop priming metal floor plate stairs.
5. Section 055119 "Metal Grating Stairs" for shop priming metal grating stairs.
6. Section 055213 "Pipe and Tube Railings" for shop [**priming**] [**painting**] pipe and tube railings.
7. [**Section 055313 "Bar Gratings"**] [**Section 055316 "Plank Gratings"**] [**Section 055319 "Expanded Metal Gratings"**] for shop priming metal gratings.
8. Section 099123 "Interior Painting."
9. Section 099300 "Staining and Transparent Finishing" for surface preparation and application of wood stains and transparent finishes on exterior wood substrates.
10. Section 099600 "High-Performance Coatings" for tile-like coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: For each type of paint system and each color and gloss of topcoat. Submit [**actual paint drawdowns as specified below**] [**paint manufacturer's standard printed cards**] for verification Samples.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in applicable exterior painting schedule articles to cross-reference paint systems specified in this Section. Include color designations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match paint products applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: [**5**] percent, but not less than [**1 gal. (3.8 L)**] of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 EXTERIOR PAINTS, GENERAL

A. Exterior Paints: Subject to compliance with requirements, [**provide product**] [**provide one of the products**] [**available products that may be incorporated into the Work include but are not limited to products**] listed in product types below and applicable exterior painting schedule articles for the paint category indicated.

B. Material Compatibility:

1. Materials for use within each paint system must be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.

C. Colors: [**As selected by Architect from manufacturer's full range**] [**Match Architect's samples**] [**As indicated in a color schedule on Drawings**] , as directed by the Owner.

1. [**10**] [**20**] [**30**] percent of surface area will be painted with deep tones.

2.3 PRIMERS

A. Alkali-Resistant, Water-Based Primer: Water-based primer formulated for use on alkaline substrates.

B. Exterior Wood Preservative: Solvent-based, zinc or copper napthenate, penetrating antifungal treatment for exterior wood.

C. Exterior, Latex Wood Primer: White, waterborne-emulsion primer formulated for resistance to extractive bleeding, mold, and microbials; for hiding stains; and for use on exterior wood substrates.

D. Exterior, Alkyd/Oil Wood Primer: Solvent-based primer formulated for resistance to extractive bleeding, sag, mold, and microbials; for hiding stains; and for use on exterior wood substrates.

E. Latex Block Filler: Water-based, pigmented, high-solids, emulsion coating formulated to bridge and fill porous surfaces of CMU substrates in preparation for specified subsequent coatings.

F. Water-Based Bonding Primer: Water-based-emulsion primer formulated to promote adhesion of subsequent specified coatings.

G. Solvent-Based Bonding Primer: Solvent-based primer formulated to seal substrates and promote adhesion of specified subsequent coatings.

H. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer; formulated for resistance to flash rusting when applied to cleaned, ferrous metal substrates subject to mildly corrosive environments.

I. Zinc-Rich, Inorganic Primer: Corrosion-resistant, inorganic-based, zinc-rich primer formulated for use on prepared ferrous metal substrates subject to severe industrial or marine environments.

1.

J. Surface-Tolerant Metal Primer: Corrosion-resistant, solvent-based metal primer formulated for use on structural steel and metal fabrications that have been minimally prepared.

K. Quick-Drying, Alkyd Metal Primer: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, ferrous metal substrates.

L. Alkyd Metal Primer: Corrosion-resistant, solvent-based, alkyd primer formulated for use on prepared ferrous metal substrates subject to industrial and light marine environments.

M. Water-Based, Galvanized-Metal Primer: Corrosion-resistant, pigmented, acrylic primer; formulated for use on cleaned/etched galvanized metal substrates to prepare it for subsequent water-based coatings.

N. Epoxy, Anticorrosive Primer: Solvent-based, two-component, epoxy, anti-corrosive primer; formulated for use on ferrous and galvanized metal substrates.

O. Vinyl Wash Primer: Two-component, vinyl butyral/phosphoric acid-wash primer formulated for use over cleaned ferrous metal substrates and zinc-rich primers as a tie coat for subsequent corrosion-resistant primers or finish coatings.

P. Quick-Drying Aluminum Primer: Corrosion-resistant, solvent-based, alkyd or modified-alkyd primer formulated for quick-drying capabilities and for use on prepared aluminum substrates.

Q. Wood-Knot Sealer: White shellac or other sealer recommended in writing by manufacturer for this purpose.

2.4 WATER-BASED FINISH COATINGS

A. Exterior Latex Paint: Water-based, pigmented coating; formulated for alkali, mold, microbial, and water resistance and for use on exterior substrates.
   1. Gloss and Sheen: Manufacturer's standard [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

B. Exterior, High-Build Latex Paint: Water-based, high-build, pigmented, emulsion coating; is formulated for abrasion, mold, microbial, and wind-driven rain resistance and for use on exterior substrates.
   1. Gloss and Sheen Level: Manufacturer's standard.

C. Textured Latex Coating: Water-based, pigmented, self-priming coating that contains sand or other hard aggregate for selected texture and is formulated for use on concrete and masonry substrates.
   1. Gloss and Sheen Level: Manufacturer's standard [**flat**] [**nonflat**].
   2. Texture: [**Manufacturer's standard**] [**Fine**] [**Medium**] [**Coarse**].

D. Exterior, Water-Based, Light Industrial Coating: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior substrates.
   1. Gloss and Sheen Level: Manufacturer's standard [**low-sheen**] [**semigloss**] [**gloss**].

E. Exterior, Water-Based Alkyd Paint: Water-based, pigmented, low-VOC alkyd paint formulated for flash rust and water resistance and for use on exterior substrates.
   1. Gloss and Sheen Level: Manufacturer's standard [**low sheen**] [**semigloss**] [**gloss**].

F. Exterior, High-Performance Architectural Latex: Water-based, pigmented, low VOC, emulsion coating formulated for use on exterior substrates.
   1. Gloss Level: Manufacturer's standard [**low sheen**] [**semigloss**].

2.5 SOLVENT-BASED FINISH COATINGS

A. Exterior Alkyd Paint: Solvent-based, pigmented, alkyd coating formulated for mold, microbial, and water resistance and for use on exterior substrates.
   1. Gloss and Sheen Level: Manufacturer's standard [**flat**] [**semigloss**] [**gloss**].

B. Quick-Drying Alkyd Paint: Solvent-based, alkyd or modified-alkyd coating formulated for quick-drying capabilities and for use on exterior substrates.
   1. Gloss Level: Manufacturer's standard [**semigloss**] [**gloss**].

C. Aluminum Paint: Aliphatic, solvent-based coating consisting of varnish or alkyd binder combined with aluminum pigment that is formulated for use as a stain-blocking coating and sealer, is able to be recoated with conventional alkyd and latex paints, and for use on wood, metal, bituminous-coated, and prepared masonry substrates.

2.6 FLOOR SEALERS AND PAINTS

A. Concrete Stain: Penetrating semitransparent stain specifically manufactured for interior and exterior concrete horizontal and vertical surfaces.

B. Latex Floor Enamel: Water-based, pigmented coating formulated to hide stains, for alkali and incidental water resistance, and for use on concrete and primed-wood substrates subject to low to medium foot traffic.
   1. Gloss and Sheen Level: Manufacturer's standard [**low gloss**] [**gloss**].
   2. Slip-Resistant Aggregate: Manufacturer's standard.

C. Latex Deck Coating: Water-based, high-solids, acrylic-emulsion coating; formulated for use on exterior substrates subject to low to medium foot traffic.
   1. Gloss Level: Manufacturer's standard.
   2. Surface Texture: [**Smooth**] [**Slip resistant**].

D. Alkyd Floor Enamel: Solvent-based, pigmented coating; self-priming where applied to bare wood; formulated to hide stains, for durability, for microbial and abrasion resistance, and for exterior substrates subject to low to medium foot traffic.
   1. Gloss Level: Manufacturer's standard [**low gloss**] [**gloss**].
   2. Slip-Resistant Aggregate: Manufacturer's standard additive.

E. Water-Based, Concrete-Floor Sealer: Clear, water-based, acrylic-copolymer-emulsion sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic substrates.

F. Solvent-Based, Concrete-Floor Sealer: Clear, acrylic, solvent-based sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

   1. Concrete: 12 percent.
   2. Cementitious Composition Board: 12 percent.
   3. Masonry (Clay and CMU): 12 percent.
   4. Wood: 15 percent.
   5. Portland Cement Plaster (Stucco): 12 percent. Verify that plaster is fully cured.

C. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers. Proceed with coating application only after unsatisfactory conditions have been corrected.

   1. Application of coating indicates acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other loose foreign matter. Clean using methods recommended in writing by paint manufacturer[**.**][**but not less than the following:**]

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7/NACE No. 4.
4. SSPC-SP 11.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed substrates.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
2. Sand surfaces that will be exposed to view and remove sanding dust.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

K. Canvas and Cotton Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

L. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION OF EXTERIOR PAINT PRODUCTS

A. Apply paints in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint [**both sides**] [**exterior side**] and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in applicable exterior painting schedule articles may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting, Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Equipment, including panelboards[**and switch gear**].
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: the Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.
3. Cost of retesting is Contractor's responsibility.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition, as directed by the Owner.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE, CONCRETE SUBSTRATES

A. Vertical (Nontraffic) Surfaces:

1. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat: Exterior, high-build latex paint.

2. Water-Based, Light Industrial Coating System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. High Performance Architectural Latex System:

   a. Prime Coat: [**Alkali-resistant, water-based primer**] [**As recommended in writing by topcoat manufacturer**].
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

4. High Performance Architectural Latex over Latex Aggregate System:

   a. Prime Coat: Textured coating, latex, flat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. Horizontal (Traffic) Surfaces:

1. Latex Floor Enamel System:

   a. Prime Coat: Matching topcoat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Latex floor enamel, [**low gloss**] [**gloss**].

2. Latex Deck Coating System:

    a. Prime Coat: As recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
    c. Topcoat: Latex deck coating.

3. Alkyd Floor Enamel System:

    a. Prime Coat: Matching topcoat.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Alkyd floor enamel, [**low gloss**] [**gloss**].
    d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

4. Solvent-Based Concrete Floor Sealer System:

    a. Prime Coat: Matching topcoat.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Solvent-based, concrete-floor sealer.

5. Water-Based Concrete Floor Sealer System:

    a. Prime Coat: Matching topcoat.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Water-based, concrete-floor sealer.

6. Latex Zone/Traffic-Marking Paint System:

    a. Traffic-marking paint, latex.

7. Alkyd Zone/Traffic-Marking Paint System:

    a. Traffic-marking paint, solvent-based.

3.7 EXTERIOR PAINTING SCHEDULE, CEMENTITIOUS SUBSTRATES

A. Cementitious Composition Board Substrates: [**Siding**] [**Trim**] [**Panels**] .

1. Latex System:

    a. Prime Coat: Matching topcoat.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

    a. Prime Coat: Alkali-resistant, water-based primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Latex Aggregate System:

    a. Prime Coat: As recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
    c. Topcoat: Exterior, textured coating, latex [**flat**] [**nonflat**].

4. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat: Exterior, high-build latex paint.

5. Water-Based, Light Industrial Coating System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

6. Alkyd System:

   a. Prime Coat: Exterior, latex wood primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

7. High Performance Architectural Latex System:

   a. Prime Coat: [**Alkali-resistant, water-based primer**] [**As recommended in writing by topcoat manufacturer**].
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. Portland Cement Plaster (Stucco) Substrates:

1. Latex System:

   a. Prime Coat: [**Matching topcoat**] [**Alkali-resistant, water-based primer**].
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat: Exterior, high-build latex paint.

3. Water-Based, Light Industrial Coating System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior water-based alkyd enamel, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Alkali-resistant, water-based primer**] [**As recommended in writing by topcoat manufacturer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

3.8 EXTERIOR PAINTING SCHEDULE, MASONRY SUBSTRATES

A. Clay Masonry Substrates:

1. Latex System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex Aggregate System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Textured latex coating, [**flat**] [**nonflat**].

3. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Exterior, high-build latex paint.

4. Water-Based, Light Industrial Coating System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

5. Water-Based Alkyd System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

6. High Performance Architectural Latex System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. CMU Substrates:

1. Latex System:

a. Prime Coat: Latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkali-Resistant Primer System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Latex Aggregate System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Textured latex coating, [**flat**] [**nonflat**].

4. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Exterior, high-build latex paint.

5. Water-Based, Light Industrial Coating System:

a. Prime Coat: Latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

6. Water-Based Alkyd System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

7. High Performance Architectural Latex System:

a. Prime Coat: [**Alkali-resistant, water-based primer**] [**Latex block filler**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

3.9 EXTERIOR PAINTING SCHEDULE, METAL SUBSTRATES

A. Steel and Iron Substrates:

1. Water-Based, Light Industrial Coating System:

a. Prime Coat: [**Zinc-rich, inorganic primer**] [**Alkyd metal primer**] [**Acrylic metal primer**] [**Epoxy metal primer**] [**Shop primer specified in Section in which substrate is specified**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating over Epoxy System:

a. Prime Coat: Epoxy metal primer.
b. Intermediate Coat: High-build epoxy paint, low gloss.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: [**Alkyd metal primer**] [**Surface-tolerant metal primer**] [**Shop primer specified in Section in which substrate is specified**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Alkyd metal primer**] [**Quick-dry, alkyd metal primer**] [**Surface-tolerant metal primer**] [**Shop primer specified in Section in which substrate is specified**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. Quick-Dry Enamel System:

a. Prime Coat: Quick-dry, alkyd metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Quick-dry alkyd enamel, [**semigloss**] [**gloss**].

6. Aluminum Paint System:

a. Prime Coat: [**Alkyd metal primer**] [**Shop primer specified in Section in which substrate is specified**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Aluminum paint.

B. Galvanized Metal Substrates:

1. Latex System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.

2. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].Water-Based, Light Industrial Coating System:

a. Prime Coat: [**Water-based, galvanized-metal primer**] [**Epoxy metal primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. Aluminum Paint System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.

c. Topcoat: Aluminum paint.

6. High Performance Architectural Latex System: <**Insert drawing designation**>

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

7. Bituminous Coating System: <**Insert drawing designation**>

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Bituminous coating.

C. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Latex System:

a. Prime Coat: Quick-dry aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: Quick-dry aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Pretreatment Coat: Vinyl wash primer.
b. Prime Coat: Quick-dry aluminum primer.
c. Intermediate Coat: Matching topcoat.
d. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Quick-dry aluminum primer**] [**Vinyl wash primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: Quick-dry aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

6. Aluminum Paint System:

a. Pretreatment Prime Coat: Vinyl wash primer.
b. Prime Coat: Quick-dry aluminum primer.
c. Intermediate Coat: Matching topcoat.
d. Topcoat: Aluminum paint.

7. Bituminous Coating System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Bituminous coating.

D. Copper Substrates:

1. Latex System:

    a. Prime Coat: Quick-dry aluminum primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

    a. Prime Coat: Quick-dry aluminum primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

    a. Pretreatment Coat: [**Vinyl wash**] [**Quick-dry aluminum**] primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

    a. Prime Coat: [**Quick-dry aluminum primer**] [**Vinyl wash primer**].
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

    a. Prime Coat: Quick-dry aluminum primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

6. Aluminum Paint System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Aluminum paint.

7. Bituminous Coating System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Bituminous coating.

E. Stainless Steel Substrates:

1. Latex System:

    a. Prime Coat: Solvent-based bonding primer.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: Quick-dry aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Solvent-based bonding primer**] [**Alkyd metal primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

6. Aluminum Paint System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Aluminum paint.

3.10 EXTERIOR PAINTING SCHEDULE, WOOD SUBSTRATES

A. Glue-Laminated Wood Substrates:

1. Latex over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.

c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. Exposed Wood-Framed Substrates:

1. Latex over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

C. Dressed-Wood Substrates: [**Wood trim**] [**Architectural woodwork**] [**Doors**] [**Windows**] [**Wood board siding**] [**Railings**] [**and**] [**Fences**] .

1. Latex over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

    a. Prime Coat: Exterior, alkyd wood primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Water-Based, Light Industrial Coating System:

    a. Prime Coat: Exterior, alkyd wood primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

4. Alkyd System:

    a. Prime Coat: Exterior, alkyd wood primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

5. Water-Based Alkyd System:

    a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

6. High Performance Architectural Latex System:

    a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

D. Wood-Based Panel Substrates:

1. Latex over Latex Primer System:

    a. Prime Coat: Exterior, latex wood primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

    a. Prime Coat: Exterior, alkyd wood primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

    a. Prime Coat: Exterior, alkyd wood primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

    a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
    b. Intermediate Coat: Matching topcoat.

c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

E. Wood-Board, Traffic-Surface Substrates: [**Lumber decking**] [**and**] [**stairs**]

1. Latex Porch and Floor Enamel over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Latex floor enamel, [**low gloss**] [**gloss**].
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

2. Latex Porch and Floor Enamel over Alkyd Primer System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Latex floor enamel, [**low gloss**] [**gloss**].
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

3. Latex Deck Coating System (for Plywood Decks):

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommending in writing by topcoat manufacturer.
c. Topcoat: Latex deck coating.
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

4. Alkyd Floor Enamel System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Alkyd floor enamel, [**low gloss**] [**gloss**].
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

5. Alkyd Floor Enamel over Wood Preservative System:

a. Preservative Coat: Exterior wood preservative.
b. Prime Coat: Matching topcoat.
c. Intermediate Coat: Matching topcoat.
d. Topcoat: Alkyd floor enamel, [**low gloss**] [**gloss**].
e. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

F. Wood Shingle and Shake Siding Substrates:

1. Latex over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

3.11 EXTERIOR PAINTING SCHEDULE, MISCELLANEOUS SUBSTRATES

A. Fiberglass Substrates:

1. Latex System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: Solvent-based bonding primer.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. Plastic Trim Fabrication Substrates:

1. Latex System:

a. Prime Coat: [**Solvent**] [**Water**]-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: [**Solvent**] [**Water**]-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: [**Solvent**] [**Water**]-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Solvent**] [**Water**]-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

C. Exterior Canvas and Cotton Substrates:

1. Latex System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Exterior latex paint, flat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

    a. Prime Coat: Exterior latex paint, flat.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. Aluminum Paint System:

    a. Prime Coat: Exterior latex paint, flat.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Aluminum paint.

6. High Performance Architectural Latex System:

    a. Prime Coat: As recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

D. Exterior Bituminous-Coated Substrates:

1. Latex System:

    a. Prime Coat: Water-based, rust-inhibitive primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex Aggregate System:

    a. Prime Coat: As recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
    c. Topcoat: Textured latex coating, [**flat**] [**nonflat**].

3. Alkyd System:

    a. Prime Coat: Water-based, rust-inhibitive primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

    a. Prime Coat: Water-based, rust-inhibitive primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. Aluminum Paint System:

    a. Prime Coat: Water-based, rust-inhibitive primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Aluminum paint.

6. High Performance Architectural Latex System:

    a. Prime Coat: Water-based, rust-inhibitive primer.
    b. Intermediate Coat: Matching topcoat.

c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

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Task	Specification	Specification Description
13 34 00 00	13 34 23 16	Fabricated Control Booths
13 34 16 00	13 34 23 16	Fabricated Control Booths
13 34 16 13	13 34 23 16	Fabricated Control Booths

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SECTION 13 34 19 00 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal building systems.
2. Structural-steel framing.
3. Metal roof panels.
4. Metal wall panels.
5. Foamed-insulation-core metal wall panels.
6. Metal soffit panels.
7. Thermal insulation.
8. Personnel doors and frames.
9. Horizontal sliding doors.
10. Windows.
11. Translucent panels.
12. Accessories.

B. Related Requirements:

1. Division 03 concrete Sections for anchor rod installation, concrete, reinforcement, and formwork requirements.
2. Section 077253 "Snow Guards" for devices designed to hold snow on the roof surface.
3. Section 083323 "Overhead Coiling Doors" for coiling vehicular doors in metal building systems.
4. Section 083613 "Sectional Doors" for sectional vehicular doors in metal building systems.

1.2 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Division 03 concrete Sections.

B. Coordinate imposed load of [**cranes**] [**HVAC**] specified in other Sections with structural performance requirements specified in this Section.

C. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conferences: Conduct conferences [**at Project site**] [**by web conference**].

1. Metal Building Systems Conference: Review methods and procedures related to metal building systems including, but not limited to, the following:

a. Condition of foundations and other preparatory work performed by other trades.
b. Structural load limitations.
c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
d. Required tests, inspections, and certifications.
e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Metal Building Roof Panel Conference: Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
b. Structural limitations of purlins and rafters during and after roofing.
c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
d. Temporary protection requirements for metal roof panel assembly during and after installation.
e. Roof observation and repair after metal roof panel installation.

3. Metal Building Wall Panel Conference: Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
b. Structural limitations of girts and columns during and after wall panel installation.
c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
d. Temporary protection requirements for metal wall panel assembly during and after installation.
e. Wall observation and repair after metal wall panel installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: By manufacturer of metal building systems. Indicate components by others. Include full building plan, elevations, sections, details, and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.

2. Structural-Framing Drawings: Indicate complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

    a. Indicate provisions for attaching [**mezzanines**] [**roof curbs**] [**service walkways**] [**platforms**] [**and**] [**pipe racks**].

3. Metal Panel Layout Drawings: Indicate [**roof**] [**and**] [**wall**]. layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; indicate locations of exposed fasteners.

    a. Indicate roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
    b. Indicate wall-mounted items including personnel doors, vehicular doors, windows, louvers, and lighting fixtures.
    c. Indicate translucent panels.

4. Accessory Drawings: Include details of the following items, at a scale of not less than [**1-1/2 inches per 12 inches (1:8)**]

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.
    d. Service walkways.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Panels: [**Manufacturers' standard size**]. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: [**Manufacturers' standard size**]. Include fasteners and other exposed accessories.
3. Vapor-Retarder Facings: Minimum 6-inch- (150-mm-) square Samples.
4. Windows: Full-size, nominal 12-inch- (300-mm-) long frame Samples showing typical profile.
5. Accessories: Samples for each type of accessory.

E. Door Schedule: For doors and frames. Use same designations indicated on Drawings. Include details of reinforcement.

1. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets, indicating complete designations of every item required for each door or opening.
2. Keying Schedule: Detail the Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

F. Delegated Design Submittals: For metal building systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.
6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, in accordance with governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

B. Welding certificates.

C. Material Test Reports: For each of the following products, by a qualified testing agency:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, and bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

D. Source quality control reports.

E. Field quality control reports.

F. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor that performed surveys certify their accuracy.

G. Qualification Statements: For [**manufacturer**] [**erector**] [**land surveyor**] [**door inspector**].

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

H. Delegated Design Engineer Qualifications: For metal building system.

I. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes[**and door hardware**].

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Accreditation: Manufacturer's facility accredited in accordance with IAS AC472.
2. Engineering Responsibility: Metal building system design and preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

D. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

E. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

F. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies is to comply with qualifications set forth in NFPA 80, Section 5.2.3.1 and with the following:

1. DHI Fire and Egress Door Assembly Inspector (FDAI) certification.

G. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies is to comply with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and with the following:

1. DHI Fire and Egress Door Assembly Inspector (FDAI) certification.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect foam-plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.

3. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed in accordance with manufacturers' written installation instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**25**] [**20**] [**10**] years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: [**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.

B. Structural Performance: Metal building systems to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with procedures in MBMA's "Metal Building Systems Manual":

1. Design Loads: [**As indicated on Drawings**].
2. Deflection and Drift Limits:

a. Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC's "Design Guide No. 3: Serviceability Design Considerations for Steel Buildings."
b. Deflection to be no greater than the following:

1) Purlins and Rafters: Vertical deflection of [**1/150**] [**1/240**] [**1/360**] of the span.
2) Girts: Horizontal deflection of [**1/120**] [**1/180**] [**1/240**] of the span.
3) Metal Roof Panels: Vertical deflection of [**1/150**] [**1/240**] [**1/360**] of the span.
4) Metal Wall Panels: Horizontal deflection of [**1/180**] [**1/240**] of the span.
5) Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
6) Lateral Drift: Maximum of [**1/60**] [**1/100**] [**1/200**] [**1/400**] of the building height.

C. Seismic Performance: Metal building system to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

E. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E119 or ASTM E108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL Product iQ, FM Approvals' "Approval Guide," or from the listings of another qualified testing agency.

F. Fire Propagation Characteristics: Exterior wall assemblies containing foam plastics pass NFPA 285 fire test.

G. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

H. Structural Performance for Metal Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E1592:

1. Wind Loads: As indicated on Drawings.

I. Air Infiltration for Metal Roof Panels: Air leakage of not more than [**0.04 cfm/sq. ft. (0.2 L/s per sq. m)**] [**0.06 cfm/sq. ft. (0.3 L/s per sq. m)**] when tested in accordance with ASTM E1680[**or ASTM E283/E283M**] at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

J. Air Infiltration for Metal Wall Panels: Air leakage of not more than [**0.04 cfm/sq. ft. (0.2 L/s per sq. m)**] [**0.06 cfm/sq. ft. (0.3 L/s per sq. m)**] when tested in accordance with ASTM E283/E283M at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

K. Water Penetration for Metal Roof Panels: No water penetration when tested in accordance with ASTM E1646[**or ASTM E331**] at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

L. Water Penetration for Metal Wall Panels: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

M. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: [**UL 30**] [**UL 60**] [**UL 90**].

N. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Approvals' "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A- [**60**] [**75**] [**90**] [**105**] [**120**].
2. Hail Resistance: [**MH**] [**SH**].

O. Thermal Performance for Opaque Elements: Provide the following maximum U-factors and minimum R-values when tested in accordance with ASTM C1363 or ASTM C518:

2.3 METAL BUILDING SYSTEMS

A. System Description: Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

1. Primary-Frame Type:

a. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
b. Rigid Modular: Solid-member, structural-framing system with interior columns.
c. Truss-Frame Clear Span: Truss-member, structural-framing system without interior columns.
d. Truss-Frame Modular: Truss-member, structural-framing system with interior columns.
e. Lean-to: Solid- or truss-member, structural-framing system, designed to be partially supported by another structure.

2. End-Wall Framing:

a. Manufacturer's standard, for buildings not required to be expandable, consisting of [**primary frame, capable of supporting one-half of a bay design load, and end-wall columns**] [**load-bearing end-wall and corner columns and rafters**].
b. Engineer end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.

3. Secondary-Frame Type: Manufacturer's standard purlins and joists and [**flush-framed**] [**partially inset-framed**] [**exterior-framed (bypass)**] girts.

4. Eave Height: [16 ft. (4.9 m)] [20 ft. (6.1 m)] [24 ft. (7.3 m)] [28 ft. (8.5 m)] [**Manufacturer's standard height, as indicated by nominal height on Drawings**].
5. Bay Spacing: [20 ft. (6.1 m)] [25 ft. (7.6 m)] [30 ft. (9.1 m)] [**As determined by manufacturer**] [**As indicated on Drawings**].
6. Roof Slope: [1/4 inch per 12 inches (1:48)] [1/2 inch per 12 inches (1:24)] [1 inch per 12 inches (1:12)] [4 inches per 12 inches (1:3)] [**Manufacturer's standard for frame type required**].
7. Roof System: Manufacturer's standard [**standing-seam, vertical-rib,**] [**standing-seam, trapezoidal-rib,**] [**lap-seam, tapered-rib**] metal roof panels.

    a. Liner Panels: Tapered rib.

8. Exterior Wall System: Manufacturer's standard [**exposed-fastener, tapered-rib,**] [**exposed-fastener, reverse-rib,**] [**concealed-fastener, flush-profile,**] [**foamed-insulation-core**] metal wall panels.

    a. Liner Panels: [**Tapered rib**] [**Flush profile**].

2.4 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360.

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Cold-Formed Steel: Comply with AISI S100 for design requirements and allowable stresses.

D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

    a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect, as directed by the Owner.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
3. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
4. Truss-Frame, Clear-Span Frames: Rafter frames fabricated from joist girders, and I-shaped column sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
5. Truss-Frame Modular Frames: Rafter frames fabricated from joist girders, and I-shaped column sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
6. Long-Bay Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
7. Frame Configuration: [**Single gable**] [**One-directional, sloped**] [**Lean-to, with high side connected to and supported by another structure**] [**Multiple gable**] [**Load-bearing wall**] [**Multistory**].
8. Exterior Column: [**Uniform depth**] [**Tapered**].

9. Rafter: [**Uniform depth**] [**Tapered**].

E. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

F. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins:

   a. C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- (64-mm-) wide flanges.
   b. Steel joists of depths indicated on Drawings.

      1) Depth: [**As indicated on Drawings**] [**As needed to comply with system performance requirements**].

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- (64-mm-) wide flanges.

   a. Depth: [**As indicated on Drawings**] [**As required to comply with system performance requirements**].

3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch (51-by-51-by-3-mm) structural-steel angles or 1-inch- (25-mm-) diameter, cold-formed structural tubing to stiffen primary-frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch (25-by-25-by-3-mm) structural-steel angles.
6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch (76-by-51-mm), fabricated from zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

G. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.

1. Type: [**Straight-beam, eave type**] [**Purlin-extension type**] [**Tapered-beam, below-eave type**] [**As indicated**].

H. Bracing: Provide adjustable wind bracing[**using any method**] as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50 (345); or ASTM A529/A529M, Grade 50 (345); minimum 1/2-inch- (13-mm-) diameter steel; threaded full length or threaded a minimum of 6 inches (152 mm) at each end.
2. Cable: ASTM A475, minimum 1/4-inch- (6-mm-) diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
5. Fixed-Base Columns: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
6. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

I. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

J. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
4. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B or C, structural tubing.
6. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55 (205 through 380), or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70 (310 through 480); or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80 (170 through 550), or HSLAS, Grades 45 through 70 (310 through 480).
7. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G60 (Z180) coating designation; mill phosphatized.
8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G90 (Z275) coating designation.
    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80 (340 or 550); with Class AZ50 (AZM150) coating.

9. Joist Girders: Manufactured in accordance with "Standard Specifications for Joist Girders," in SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for primary framing.
10. Steel Joists: Manufactured in accordance with "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for secondary framing.
11. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563/A563M carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.

a. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

12. High-Strength Bolts, Nuts, and Washers, Grade A325 (Grade A325M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M, Grade DH (Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

    a. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

13. High-Strength Bolts, Nuts, and Washers, Grade A490 (Grade A490M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts[**or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends**]; ASTM A563/A563M, Grade DH (Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
14. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, [**heavy-hex**] [**round**] head assemblies consisting of steel structural bolts with splined ends; ASTM A563/A563M, Grade DH (Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.

    a. Finish: [**Plain**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**] [**Mechanically deposited zinc coating, ASTM B695, Class 50, baked-epoxy coated**].

15. Unheaded Anchor Rods: [**ASTM F1554, Grade 36**] [**ASTM A572/A572M, Grade 50 (345)**] [**ASTM A36/A36M**] [**ASTM A307, Grade A**].

    a. Configuration: Straight.
    b. Nuts: ASTM A563/A563M, [**heavy-**]hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436/F436M, hardened carbon steel.
    e. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

16. Headed Anchor Rods: [**ASTM F1554, Grade 36**] [**ASTM A307, Grade A**].

    a. Configuration: Straight.
    b. Nuts: ASTM A563/A563M, [**heavy-**]hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436/F436M, hardened carbon steel.
    e. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

17. Threaded Rods: [**ASTM A193/A193M**] [**ASTM A572/A572M, Grade 50 (345)**] [**ASTM A36/A36M**] [**ASTM A307, Grade A**].

    a. Nuts: ASTM A563/A563M, [**heavy-**]hex carbon steel.
    b. Washers: [**ASTM F436/F436M, hardened**] [**ASTM A36/A36M**] carbon steel.
    c. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

K. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.
2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil (0.025 mm).

a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil (0.013 mm) on each side.

2.5 METAL ROOF PANELS

A. Solar Reflectance Index:

B. Roof Solar Reflectance: Provide roof panels with one of the following when tested in accordance with CRRC-1:

1. Three-year, aged, solar reflectance of not less than [**0.55**] and emissivity of not less than [**0.75**].
2. Three-year, aged, Solar Reflectance Index (SRI) of not less than [**64**] when calculated in accordance with ASTM E1980.

C. Standing-Seam, Vertical-Rib, Metal Roof Panels : Formed with vertical ribs at panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Clips: [**One-piece fixed**] [**Two-piece floating**] to accommodate thermal movement.
3. Joint Type: [**Panels snapped together**] [**Mechanically seamed**].
4. Panel Coverage: [**16 inches (406 mm)**].
5. Panel Height: [**2 inches (51 mm)**].

D. Standing-Seam, Trapezoidal-Rib, Metal Roof Panels : Formed with raised trapezoidal ribs at panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Clips: [**One-piece fixed**] [**Two-piece floating**] to accommodate thermal movement.
3. Joint Type: [**Panels snapped together**] [**Mechanically seamed**].
4. Panel Coverage: [**24 inches (610 mm)**].
5. Panel Height: [**3 inches (76 mm)**].
6. Uplift Rating: [**UL 30**] [**UL 60**] [**UL 90**].

E. Exposed Fastener, Tapered-Rib, Metal Roof Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be

installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

F. Exposed-Fastener, Tapered-Rib, Metal Liner Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

G. Finishes:

1. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.6 METAL WALL PANELS

A. Exposed-Fastener, Tapered-Rib, Metal Wall Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

B. Exposed-Fastener, Reverse-Rib, Metal Wall Panels : Formed with recessed, trapezoidal major valleys and [**intermediate stiffening valleys symmetrically spaced**] [**flat pan**] between major valleys; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

C. Concealed-Fastener, Flush-Profile, Metal Wall Panels : Formed with vertical panel edges and [**a single wide recess, centered between panel edges**] [**flush surface**]; with flush joint between panels; with 1-inch- (25-mm-) wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Panel Coverage: [**16 inches (406 mm)**].
3. Panel Height: [**3 inches (76 mm)**].

D. Tapered-Rib, Metal Liner Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Siliconized polyester**] [**Acrylic enamel**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

E. Flush-Profile, Metal Liner Panels: [**Solid**] [**Perforated**] panels formed with vertical panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between panel edges; with flush joint between panels; designed for interior side of metal wall panel assemblies and installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Siliconized polyester**] [**Polyester**] [**Acrylic enamel**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Sound Absorption: NRC not less than [**0.65**] [**0.85**] [**1.00**] when tested in accordance with ASTM C423.
3. Panel Coverage: [**12 inches (305 mm)**].
4. Panel Height: [**1.5 inches (38 mm)**].

F. Finishes:

1. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.7 FOAMED-INSULATION-CORE METAL WALL PANELS

A. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels : Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Facing Material: Fabricate panel with exterior and interior facings of same material and thickness. Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Surface: [**Smooth, flat**] [**Striated**] [**Shallow ribs**] [**Shallow V grooves**].
   b. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   c. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Panel Coverage: [**36 inches (914 mm)**] [**42 inches (1067 mm)**] nominal.
3. Panel Thickness: [**2 inches (51 mm)**] [**2.5 inches (64 mm)**] [**3 inches (76 mm)**] [**4 inches (102 mm)**] [**5 inches (127 mm)**] [**6 inches (152 mm)**].
4. Insulation Core: Modified polyisocyanurate or polyurethane foam using a non-CFC blowing agent, foamed-in-place or board type, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

   a. Closed-Cell Content: 90 percent when tested in accordance with ASTM D6226.
   b. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested in accordance with ASTM D1622.
   c. Compressive Strength: Minimum 20 psi (140 kPa) when tested in accordance with ASTM D1621.
   d. Shear Strength: 26 psi (179 kPa) when tested in accordance with ASTM C273/C273M.

5. Fire-Test-Response Characteristics: Class A in accordance with ASTM E108.
6. Surface-Burning Characteristics: Flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

B. Finishes:

1. Exposed Coil-Coated Finish:

   a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.8 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal [**roof**] [**wall**] panels.

1. Finish: [**Match finish and color of metal roof panels**] [**Match finish and color of metal wall panels**] [**As indicated on Drawings**].

C. Exposed-Fastener, Tapered-Rib-Profile, Metal Soffit Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

D. Concealed-Fastener, Flush-Profile, Metal Soffit Panels : Formed with vertical panel edges and [**a single wide recess, centered between panel edges**] [**flush surface**]; with flush joint between panels; with 1-inch- (25-mm-) wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Panel Coverage: [**12 inches (305 mm)**] [**16 inches (406 mm)**].
3. Panel Height: [**1 inch (25 mm)**] [**1.5 inches (38 mm)**].

2.9 THERMAL INSULATION

A. Faced Metal Building Insulation: ASTM C991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

B. Unfaced Metal Building Insulation: ASTM C991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

C. Mineral-Fiber-Blanket Insulation: ASTM C665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.

1. Nonreflective Faced: Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
2. Reflective Faced: Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
3. Unfaced: Type I (blankets without membrane covering), passing ASTM E136 for combustion characteristics.

D. Faced, Polyisocyanurate Board Insulation: ASTM C1289, Type I (foil facing), Class 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core. Provide units tested for interior exposure without an approved thermal barrier.

E. Retainer Strips: For securing insulation between supports, 0.025-inch (0.64-mm) nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.

F. Vapor-Retarder Facing: ASTM C1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested in accordance with ASTM E96/E96M, Desiccant Method.
1. Composition:

a. White metallized-polypropylene film facing, fiberglass scrim reinforcement, and kraft-paper backing.
b. Aluminum foil facing, elastomeric barrier coating, fiberglass scrim reinforcement, and kraft-paper backing.
c. White [**polypropylene**] [**vinyl**] film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.
d. White polypropylene film facing and fiberglass-polyester-blend fabric backing.

G. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.10 PERSONNEL DOORS AND FRAMES

A. Swinging Personnel Doors and Frames:

1. As specified in Section 081113 "Hollow Metal Doors and Frames."
2. Metal building system manufacturer's standard doors and frames; prepared and reinforced at strike and at hinges to receive factory- and field-applied hardware in accordance with BHMA A156 Series.

a. Steel Doors: 1-3/4 inches (44.5 mm) thick; fabricated from metallic-coated steel face sheets, 0.036-inch (0.91-mm) nominal uncoated steel thickness, of [**seamed**] [**seamless**], hollow-metal construction; with 0.060-inch (1.52-mm) nominal uncoated steel thickness, inverted metallic-coated steel channels welded to face sheets at top and bottom of door.

1) Design: [**Flush panel**] [**As indicated on Drawings**].
2) Core:

a) Kraft honeycomb with U-factor rating of at least 0.47 Btu/sq. ft. x h x deg F (2.67 W/sq. m x K).
b) Polystyrene foam with U-factor rating of at least 0.16 Btu/sq. ft. x h x deg F (0.91 W/sq. m x K).
c) Polyurethane foam with U-factor rating of at least 0.07 Btu/sq. ft. x h x deg F (0.40 W/sq. m x K).

3) Glazing Frames: Steel frames to receive field-installed glass.
4) Glazing: As specified in Section 088000 "Glazing."

b. Steel Frames: Fabricate 2-inch- (51-mm-) wide face frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.060-inch (1.52-mm) nominal uncoated steel thickness.

1) Type: [**Knocked down for field assembly**] [**Factory welded**].

c. Fabricate concealed stiffeners, reinforcement, edge channels, and moldings from either cold- or hot-rolled steel sheet.
d. Hardware:

1) Provide hardware for each door leaf, as follows:

a) Hinges: BHMA A156.1. Three [**plain**] [**antifriction**]-bearing, standard-weight, full-mortise, stainless steel or bronze, template-type hinges; 4-1/2 by 4-1/2 inches (114 by 114 mm), with nonremovable pin.
b) Lockset: BHMA A156.2. [**Key-in-lever cylindrical**] [**Mortise, with lever handle**] type.
c) Exit Device: BHMA A156.3. Touch- or push-bar type.
d) Threshold: BHMA A156.21. Extruded aluminum.
e) Silencers: Pneumatic rubber; three silencers on strike jambs of single door frames and two silencers on heads of double door frames.
f) Closer: BHMA A156.4. Surface-applied, standard-duty hydraulic type.
g) Weather Stripping: Vinyl applied to head and jambs, with vinyl sweep at sill.

2) Provide each pair of double doors with the following hardware in addition to that specified for each leaf:

a) Astragal: Removable type.
b) Surface Bolts: Top and bottom of inactive door.

e. Anchors and Accessories: Manufacturer's standard units, galvanized in accordance with ASTM A123/A123M.
f. Fabrication: Fabricate doors and frames to be rigid; neat in appearance; and free from defects, warp, or buckle. Provide continuous welds on exposed joints; grind, dress, and make welds smooth, flush, and invisible.

B. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS, Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS, Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.

C. Finishes for Personnel Doors and Frames:

1. Prime Finish: Factory-apply manufacturer's standard primer immediately after cleaning and pretreating.

a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2. Factory-Applied Paint Finish: Manufacturer's standard, complying with SDI A250.3 for performance and acceptance criteria.

a. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.11 HORIZONTAL SLIDING DOORS

A. Horizontal-Sliding Doors: Manufacturer's standard horizontal-sliding door assembly including structural frame, door panels, brackets, guides, tracks, hardware, and installation accessories.

1. Door Frames: Channels and zees; metallic-coated steel sheet or structural-steel shapes, 0.060-inch (1.52-mm) nominal uncoated steel thickness.
2. Door Panels: Same material and finish as metal wall panels.
3. Hardware: Manufacturer's standard metallic-coated steel track, bottom guides, lock angles for side closure, and brackets. Support each door leaf by two four-wheel trolleys. Provide metallic-coated steel handle for each leaf, and slide bolt or padlock hasp. Flash top of track with metallic-coated steel sheet hood.

2.12 WINDOWS

A. Aluminum Windows:

1. As specified in Section 085113 "Aluminum Windows."
2. Metal building system manufacturer's standard, with self-flashing mounting fins, and as follows:

a. Type, Performance Class, and Performance Grade: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 and as follows:

1) Horizontal-Sliding Units: [**HS-LC25**] [**HS-CW30**].
2) Single-Hung Units: [**H-LC25**] [**H-CW30**].
3) Fixed Units: [**FW-LC25**] [**FW-CW30**] [**FW-AW40**].

b. Aluminum Extrusions: ASTM B221 (ASTM B221M), alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 0.064-inch (1.63-mm) thickness at any location for main frame and sash members.

1) Thermally Improved Construction: Fabricate window units with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

c. Mullions: Between adjacent windows, fabricated of extruded aluminum matching finish of window units.
d. Fasteners, Anchors, and Clips: Nonmagnetic stainless steel, aluminum, or other noncorrosive material, compatible with aluminum window members, trim, hardware, anchors, and other components of window units. Fasteners are not to be exposed, except for attaching hardware.

1) Reinforcement: Where fasteners screw-anchor into aluminum less than 0.128 inch (3.26 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, spline grommet nuts.

e. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:

1) Cam-action sweep sash lock and keeper at meeting rails.
2) Spring-loaded, snap-type lock at jambs.
3) Pole-operated, cam-action locking device on meeting rail where rail is more than 72 inches (1830 mm) above floor.
4) Lift handles for single-hung units.
5) Nylon sash rollers for horizontal-sliding units.
6) Steel or bronze operating arms.

f. Sliding-Type Weather Stripping: Woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric; complying with AAMA 701/702.
g. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, and as follows:

1) Aluminum Wire Fabric: 18-by-18 (1.1-by-1.1-mm), 18-by-16 (1.1-by-1.3-mm), or 18-by-14 (1.1-by-1.5-mm) mesh of 0.013-inch- (0.3-mm-) diameter, coated aluminum wire.
2) Glass-Fiber Mesh Fabric: 18-by-16 (1.1-by-1.3-mm) or 18-by-14 (1.1-by-1.5-mm) mesh of PVC-coated, glass-fiber threads, woven and fused to form a fabric mesh; complying with ASTM D3656/D3656M.
3) Fabric: Manufacturer's standard aluminum wire fabric or glass-fiber mesh fabric.

B. Glazing: Comply with requirements specified in Section 088000 "Glazing."

1. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear), 3 mm thick.
2. Heat-Treated Float Glass: ASTM C1048, Type I, Quality-Q3, Class I (clear), Condition A, 3 mm thick.
3. Tinted Float Glass: ASTM C1036, Type I, Quality-Q3, Class 2, 3 mm thick.

a. Tint Color: [**Blue**] [**Blue-green**] [**Bronze**] [**Green**] [**Gray**] [**Manufacturer's standard color**].

4. Patterned Glass: ASTM C1036, Type II, Quality-Q6, Class 1 (clear), Form 3, Pattern P3 (random), 3 mm thick.
5. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of 2.5-mm-thick clear float glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
6. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201.

a. Provide safety glazing labeling.

7. Glazing Stops: Screw-applied or snap-on glazing stops coordinated with Section 088000 "Glazing" and with glazing system indicated. Match material and finish of window frames.

8. Factory-Glazed Fabrication: Glaze window units in the factory to greatest extent possible and practical for applications indicated. Comply with requirements in Section 088000 "Glazing."

C. Finish:

1. Mill finish.
2. Baked-Enamel Finish, Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 0.7 mil (0.02 mm), medium gloss.

a. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.13 TRANSLUCENT PANELS

A. Uninsulated Translucent Panels: Glass-fiber-reinforced polyester, translucent plastic; complying with ASTM D3841, [**Type CC2 (general purpose)**] [**Type CC1 (limited flammability)**], Grade 1 (weather resistant); smooth finish on both sides. Match profile of adjacent metal panels.

1. Roof Panel Weight: Not less than 8 oz./sq. ft. (2441 g/sq. m).
2. Wall Panel Weight: Not less than 6 oz./sq. ft. (1831 g/sq. m).
3. Light Transmittance: Not less than [**55**] percent in accordance with ASTM D1494.
4. Metal Edge: Fabricate full length of each side of panel with metal edge for seaming into standing-seam roof panel joint.
5. Color: [**White**].

B. Insulated Translucent Panels: Fabricate insulating units of two sheets of glass-fiber-reinforced polyester, translucent plastic separated by an air space; complying with ASTM D3841, Type CC1 (limited flammability), Grade 1 (weather resistant); smooth finish on both sides. Match profile of adjacent metal panels.

1. Exterior Panel Weight: Not less than [**8 oz./sq. ft. (2441 g/sq. m)**] [**6 oz./sq. ft. (1831 g/sq. m)**].
2. Interior Panel Weight: Not less than [**8 oz./sq. ft. (2441 g/sq. m)**] [**6 oz./sq. ft. (1831 g/sq. m)**] [**4 oz./sq. ft. (1221 g/sq. m)**].
3. Light Transmittance: Not less than [**42**] percent in accordance with ASTM D1494.
4. Metal Edge: Fabricate full length of each side of panel with metal edge for seaming into standing-seam roof panel joint.
5. Color: [**White**].

C. Mastic for Translucent Panels: Nonstaining, saturated vinyl polymer as recommended by translucent panel manufacturer for sealing laps.

D. Performance:

1. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**25**] or less.
b. Smoke-Developed Index: [**450**] or less.

2.14 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from [**steel**] [**stainless steel**] sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from [**steel**] [**stainless steel sheet or nylon-coated aluminum**] sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch (25-mm) standoff; fabricated from extruded polystyrene.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

E. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake

trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2438-mm-) long sections, sized in accordance with manufacturer's written instructions.

1. Gutter Supports: Fabricated from same material and finish as gutters.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-ft.- (3-m-) long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Service Walkways: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness, steel plank grating; with slip-resistant pattern; [**18-inch (457-mm)**] [**24-inch (610-mm)**] [**36-inch (914-mm)**] overall width. Support walkways on framing system anchored to metal roof panels without penetrating panels; with predrilled holes and clamps or hooks for anchoring.

H. Roof Ventilators: Gravity type, complete with hardware, flashing, closures, and fittings.

1. Circular-Revolving Type: Minimum [**20-inch- (508-mm-)**] diameter throat opening; zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness, with coil coating; finished to match metal roof panels; with matching base and rain cap.

    a. Type: [**Directional**] [**Stationary**] revolving.
    b. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; or aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.6-mm) wire.
    c. Dampers: Spring-loaded, butterfly type; pull-chain operation; with pull chain of length required to reach within 36 inches (914 mm) of floor.
    d. Reinforce and brace units, with joints properly formed and edges beaded to be watertight under normal positive-pressure conditions.
    e. Mount ventilators on square-to-round bases for ridge or on-slope mounting, designed to match roof pitch and roll formed to match metal roof panel profile.

2. Continuous or Sectional-Ridge Type: Factory-engineered and -fabricated, continuous unit; Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal roof panels. Fabricated in minimum 10-ft.- (3-m-) long sections. Provide throat size and total length indicated, complete with side baffles, ventilator assembly, end caps, splice plates, and reinforcing diaphragms.

    a. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; or aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.6-mm) wire.
    b. Dampers: Manually operated, spring-loaded, vertically rising type; chain and worm gear operator; with pull chain of length required to reach within 36 inches (914 mm) of floor.
    c. Throat Size: [9 inches (229 mm)] [12 inches (305 mm)][as standard with manufacturer, and as required to comply with ventilation requirements].

I. Louvers: Size and design indicated; self-framing and self-flashing. Fabricate welded frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness; finished to match metal wall panels. Form blades from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.036-inch (0.91-mm) nominal uncoated steel thickness; folded or beaded at edges, set at an angle that excludes driving rains, and secured to frames by riveting or welding. Fabricate louvers with equal blade spacing to produce uniform appearance.

1. Blades:

    a. Fixed.
    b. Adjustable type, with weather-stripped edges, and manually operated by hand crank or pull chain.

2. Free Area: Not less than [**7.0 sq. ft. (0.65 sq. m)**] for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
3. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; with rewirable frames, removable and secured with clips; fabricated of same kind and form of metal and with same finish as louvers.

    a. Mounting: [**Interior**] [**Exterior**] face of louvers.

4. Vertical Mullions: Provide mullions at spacings recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

J. Roof Curbs: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness prepainted with coil coating; finished to match metal roof panels; with welded top box and bottom skirt, and integral full-length cricket; capable of withstanding loads of size and height indicated.

1. Curb Subframing: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.060-inch (1.52-mm) nominal uncoated steel thickness, angle-, C-, or Z-shaped metallic-coated steel sheet.
2. Insulation: 1-inch- (25-mm-) thick, rigid type.

K. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

L. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
2. Fasteners for Metal Roof Panels:

    a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
    b. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.

3. Fasteners for Metal Wall Panels:

    a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws[with EPDM sealing washers bearing on weather side of metal panels].
    b. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head[with EPDM sealing washers bearing on weather side of metal panels].

4. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
5. Blind Fasteners: High-strength aluminum or stainless steel rivets.
6. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

7. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
8. Metal Panel Sealants:

    a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
    b. Joint Sealant: ASTM C920; one part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.15 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members to be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming in accordance with SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming in accordance with SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.16 SOURCE QUALITY CONTROL

A. Special Inspection: the Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed in accordance with Contract requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted in accordance with manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system in accordance with manufacturer's written instructions and erection drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, in accordance with AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

    a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Steel Joists and Joist Girders: Install joists[girders,] and accessories plumb, square, and true to line; securely fasten to supporting construction in accordance with SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Joint Installation:

    a. Bolt joists to supporting steel framework using carbon-steel bolts unless otherwise indicated.
    b. Bolt joists to supporting steel framework using high-strength structural bolts unless otherwise indicated. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
    c. Weld joist seats to supporting steel framework.

5. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 INSTALLATION OF METAL PANELS, GENERAL

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate in accordance with equipment manufacturer's written instructions and to comply with details shown.

C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

E. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

F. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types used in tested assemblies meeting "Performance Requirements" Article.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.5 INSTALLATION OF METAL ROOF PANELS

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge[**and hip**] caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling or self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction. Predrill panels for fasteners.
6. Provide metal closures at [**peaks**] [**rake edges**] [**rake walls**] [**and**] each side of ridge[**and hip**] caps.

C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

E. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 ft. (6 mm in 6 m) on slope and location lines and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 INSTALLATION OF METAL WALL PANELS

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. When two rows of metal panels are required, lap panels 4 inches (102 mm) minimum.
4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
5. Rigidly fasten base end of metal wall panels and allow eave end free movement for thermal expansion and contraction. Predrill panels.
6. Flash and seal metal wall panels with weather closures at eaves and rakes, and at perimeter of all openings. Fasten with self-tapping screws.
7. Install screw fasteners in predrilled holes.
8. Install flashing and trim as metal wall panel work proceeds.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated on Drawings; if not indicated, as necessary for waterproofing.
10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer[**using sealants and gaskets as required for a watertight installation**].

C. Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint using concealed clip and fasteners at maximum 42 inches (1067 mm) o.c., spaced not more than manufacturer's written instruction. Fully engage tongue and groove of adjacent insulated metal wall panels.

1. Install clips to supports with self-tapping fasteners.
2. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels as weather seal.

D. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 ft. (6 mm in 6 m), noncumulative; level, plumb, and on location lines; and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.7 INSTALLATION OF TRANSLUCENT PANELS

A. Translucent Panels: Attach translucent panels to structural framing with fasteners in accordance with manufacturer's written instructions. Install panels perpendicular to supports unless otherwise indicated. Anchor translucent panels securely in place, with provisions for thermal and structural movement.

1. Provide end laps of not less than 6 inches (152 mm) and side laps of not less than 1-1/2-inch (38-mm) corrugations for metal roof panels.
2. Provide end laps of not less than 4 inches (102 mm) and side laps of not less than 1-1/2-inch (38-mm) corrugations for metal wall panels.
3. Align horizontal laps with adjacent metal panels.
4. Seal intermediate end laps and side laps of translucent panels with translucent mastic.

3.8 INSTALLATION OF METAL SOFFIT PANELS

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.9 INSTALLATION OF THERMAL INSULATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, in accordance with manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.
3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.
4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation, with both sets of facing tabs sealed, to provide a complete vapor retarder.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal roof panels fastened to secondary framing.
2. Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.
3. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.

    a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

4. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.

    a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

5. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
2. Sound-Absorption Insulation: Where sound-absorption requirement is indicated for metal liner panels, cover insulation with polyethylene film and provide inserts of wire mesh to form acoustical spacer grid.

D. Board Wall Insulation: Extend board insulation in thickness indicated to cover entire wall. Hold in place by metal wall panels fastened to secondary framing. Comply with manufacturers' written instructions.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.10 INSTALLATION OF DOORS AND FRAMES

A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place in accordance with manufacturers' written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

B. Personnel Doors and Frames: Install doors and frames in accordance with NAAMM-HMMA 840. Fit non-fire-rated doors accurately in their respective frames, with the following clearances:

1. Between Doors and Frames at Jambs and Head: 1/8 inch (3 mm).
2. Between Edges of Pairs of Doors: 1/8 inch (3 mm).
3. At Door Sills with Threshold: 3/8 inch (9.5 mm).
4. At Door Sills without Threshold: 3/4 inch (19.1 mm).
5. At fire-rated openings, install frames in accordance with, and doors with clearances specified in, NFPA 80.

C. Sliding Service Doors: Bolt support angles to opening head members through factory-punched holes. Bolt door tracks to support angles at maximum 24 inches (610 mm) o.c. Set doors and operating equipment with necessary hardware, jamb and head mold stops, continuous hood flashing, anchors, inserts, hangers, and equipment supports.

D. Field Glazing: Comply with installation requirements in Section 088000 "Glazing."

E. Door Hardware:

1. Install surface-mounted items after finishes have been completed at heights indicated in DHI's TDH-009.
2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
4. Set thresholds for exterior doors in full bed of sealant complying with requirements for concealed mastics specified in Section 079200 "Joint Sealants."

3.11 INSTALLATION OF WINDOWS

A. General: Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fasten in place in accordance with manufacturer's written instructions. Coordinate installation

with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels.

1. Separate dissimilar materials from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440.

B. Set sill members in bed of sealant or with gaskets, for weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Mount screens directly to frames with tapped screw clips.

3.12 INSTALLATION OF ACCESSORIES

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

E. Circular Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Mount ventilators on flat level base. Install preformed filler strips at base to seal ventilator to metal roof panels.

F. Continuous Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Join sections with splice plates and end-cap skirt assemblies where required to achieve indicated length. Install preformed filler strips at base to seal ventilator to metal roof panels.

G. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.

1. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.
3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of corrosion-resistant paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

H. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

I. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.13 FIELD QUALITY CONTROL

A. Special Inspections: the Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Door Inspections:

1. Door Inspection Agency: [**the Owner will engage**] [**Engage**] a qualified inspector to perform inspections and to furnish reports to Architect, as directed by the Owner.
2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
3. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
4. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
5. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
6. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in [**NFPA 80**] [**and**] [**NFPA 101**].
7. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 ADJUSTING

A. Doors: After completing installation, test and adjust doors to operate easily, free of warp, twist, or distortion.

B. Door Hardware: Adjust and check each operating item of door hardware and each door to ensure proper operation and function of every unit. Replace units that cannot be adjusted to operate as intended.

C. Windows: Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and at weather stripping to ensure smooth operation and weathertight closure. Lubricate hardware and moving parts.

D. Roof Ventilators and Adjustable Louvers: After completing installation, including work by other trades, lubricate, test, and adjust units to operate easily, free of warp, twist, or distortion as needed to provide fully functioning units.

1. Adjust louver blades to be weathertight when in closed position.

3.15 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting:

1. After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing[bearing plates,] and accessories.

a. Clean and prepare surfaces by SSPC-SP 2 or SSPC-SP 3.
b. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

E. Doors and Frames: Immediately after installation, sand rusted or damaged areas of prime coat until smooth and apply touchup of compatible air-drying primer.

1. Immediately before final inspection, remove protective wrappings from doors and frames.

F. Windows: Clean metal surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances. Clean factory-glazed glass immediately after installing windows.

G. Louvers: Clean exposed surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

1. Restore louvers damaged during installation and construction period so no evidence remains of corrective work. If results of restoration are unsuccessful, as directed by the Owner, remove damaged units and replace with new units.

a. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 13 34 19 00

Task	Specification	Specification Description
13 34 19 00	13 34 23 16	Fabricated Control Booths
13 34 23 00	13 34 23 16	Fabricated Control Booths
13 34 23 13	13 34 19 00	Metal Building Systems
13 34 23 13	13 34 23 16	Fabricated Control Booths
13 34 23 14	13 34 23 16	Fabricated Control Booths

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SECTION 13 34 23 16 - FABRICATED CONTROL BOOTHS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fabricated steel control booths.
2. Fabricated aluminum control booths.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Fabricated steel control booths.
2. Fabricated aluminum control booths.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control booths.
2. Include rated capacities, operating characteristics, and electrical characteristics, for included systems.

C. Shop Drawings: For control booths. Include plans, elevations, sections, details, accessories, and fastening and anchorage details, including mechanical fasteners.

1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates. Include location, diameter, and projection of anchor bolts required to attach control booths to foundation. Indicate post reactions at each location.

D. Samples: For each exposed product and for each color and texture specified, approximately **8-1/2 by 11 inches (215 by 280 mm)** in size.

E. Samples for Initial Selection: For each type of exposed finish.

F. Samples for Verification: For each type of exposed finish in manufacturer's standard sizes.

1. Include Samples of wall panels and accessories to verify finish selection.

G. Delegated Design Submittals: For fabricated control booths, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For control booths to include in maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair finish or replace control booths that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fabricated control booths.

B. Structural Performance: Fabricated control booths to withstand the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]

1. Loads: [**As indicated on Drawings**].

C. Seismic Performance: Fabricated control booths to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Loads: [**As indicated on Drawings**].

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

E. Ballistic Resistance: Provide components, including windows, walls, and doors, identical to those tested for compliance with requirements indicated, and as follows:

1. UL Rating: [**Listed and labeled as**][**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**] when tested in accordance with UL 752.
2. NIJ Classification: [**Type I**][**Type IIA**][**Type II**][**Type IIIA**][**Type III**][**Type IV**] when tested in accordance with NIJ STD-0108.01.

F. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and marked for intended location and application.

G. Safety Glazing: Comply with 16 CFR 1201, Category II.

1. Safety Glazing Labeling: Permanently mark glazing with certification label of [the SGCC][the SGCC or another certification agency acceptable to authorities having jurisdiction][manufacturer], indicating manufacturer's name, glass type, thickness, and safety glazing standard with which glass complies.

H. Regulatory Requirements: Comply with applicable provisions in [**the U.S. Department of Justice's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**].

2.2 FABRICATED STEEL CONTROL BOOTHS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Austin Mohawk and Company, Inc.**]
2. [**B.I.G. Enterprises, Inc**]
3. [**Delta Scientific Corporation**]
4. [**Keystone Structures, Inc.**]
5. [**Little Buildings, Inc.**]
6. [**Panel Built, Inc.**]
7. [**Par-Kut International, Inc**]
8. [**Porta-King Building Systems; a division of Jay Henges Enterprises, Inc.**]
9. [**United Partition Systems, Inc.**]

B. Building Style: [**Standard square corners**][**Radius corners**][**Round corners**][**Butt-glazed corners**][**Wraparound type, with single rounded building end**][**Wraparound type, with both building ends rounded**][**As indicated on Drawings**].

C. Structural Framework: Fabricated from **2-by-2-by-0.075-inch (51-by-51-by-1.90-mm)** steel structural or mechanical tubing. Connect framework by welding.

D. Sliding Doors: Top suspended from aluminum track with ball-bearing rollers; **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from [**clear-anodized aluminum**][**galvanized steel**]; with [**top half**][**full height**] of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping. Provide door on [**one side**][**both sides**] of booth.

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**] glass.
2. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.

E. Swinging Doors: **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from [**clear-anodized aluminum**][**galvanized steel**]; with [**top half**][**full height**] of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.[**Provide door on back of booth.**]

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**] glass.
2. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.

F. Windows: Extruded-aluminum sash frames glazed with clear [**tempered**][**insulating**] glass.

1. Frame Finish: Manufacturer's standard mill or clear anodic.
2. Operable Windows: Equip windows with cam locks, weather stripping, and [**stainless steel**][**nylon**] ball-bearing rollers.
3. Screens: [**Insect**][**Security**] screens for each window.
4. Corner Shape: [**Square**][**Round**].

G. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet; and interior face panel fabricated from [0.064-inch (1.63-mm)][0.052-inch (1.32-mm)] nominal-thickness, galvanized-steel sheet; with [2-inch- (51-mm-)][3-inch-(76-mm-)] thick, [rigid fiberglass][polystyrene board] insulation in cavity between exterior and interior face panels.

H. Raised Base Assembly: [4-inch- (102-mm-)][3-inch- (76-mm-)] high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from 2-by-4-inch (51-by-102-mm) galvanized-steel structural tubing; 0.108-inch (2.74-mm) nominal-thickness, C-shaped, galvanized-steel sheet channels; or galvanized structural-steel angles. Include anchor clips fabricated from 1/4-inch- (6-mm-) thick galvanized-steel plate, predrilled and welded to exterior of integral floor frame.

1. Tread Plate Floor Assembly: 0.108-inch (2.74-mm) nominal-thickness, galvanized, rolled steel tread plate.
2. Insulated Floor Assembly: Assembly consisting of 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet underside with rigid insulation core; covered by 0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate; with overall assembly thickness of 2 inches (51 mm).
3. Uninsulated Floor Assembly: Assembly consisting of [**one**][**two**] layer(s) of 3/4-inch- (19-mm-) thick plywood or oriented strand board with [0.125-inch- (3.18-mm-) **thick, aluminum rolled tread plate**][**vinyl composition flooring**][**carpeting**].

I. Flush Base Assembly: No perimeter frame, with finished floor fabricated from 0.108-inch (2.74-mm) nominal-thickness, galvanized, rolled steel tread plate.

J. Open Base: No perimeter frame, with surface of supporting concrete base as finished floor.

K. Flat Roof/Ceiling Assembly: Assembly consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.

1. Exterior Roof Panel: Fabricated from [0.079-inch (2.01-mm)][0.064-inch (1.63-mm)] nominal-thickness, galvanized-steel sheet; with [painted finish][EPDM membrane], continuously welded seams[and full-perimeter gutter].
2. Interior Ceiling Panel: Fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet; with fiberglass insulation in cavity between ceiling and roof.
3. Insulated Composite Panel: Fabricated from 0.028-inch (0.71-mm) nominal-thickness, galvanized-steel sheet faces and expanded-foam insulation core.
4. Canopy Fascia: Fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet, of [**manufacturer's standard design**][**custom design indicated on Drawings**].

    a. Height: [6 inches (152 mm)][8 inches (203 mm)].
    b. Configuration:

        1) Overhang [3 inches (76 mm)] beyond face of walls below.
        2) Flush with face of walls below.

5. Downspouts: Integral, extending 3 inches (76 mm) beyond booth walls.
6. Roof scuppers.
7. Rooftop finial.

L. Work Counters: Full width of control booth, reinforced; with 16-inch- (406-mm-) wide [**storage**][**cash**] drawer below each counter and an access opening for electrical cords at[**each**] rear corner of counter.

1. Material: [0.078-inch- (1.98-mm-) **thick, stainless steel sheet**][0.079-inch (2.01-mm) **nominal-thickness, galvanized-steel sheet**][1/2-inch- (13-mm-) **thick particleboard with plastic-laminate finish**].
2. Depth: [18 inches (457 mm)][20 inches (508 mm)][22 inches (559 mm)].

M. Electrical:

1. Single-Point Connection: Service-entrance-rated, fused safety switch located on exterior for connection of 125 A, [**120/240 V, single-phase, three-wire**][**120/208 V, single-phase, three-**

wire][**208Y/120 V, three-phase, four-wire**] feeder with equipment ground conductor.

2. Grounding: Grounding electrode bonded to equipment ground conductor at single-point connection in accordance with NFPA 70 and Section 260526 "Grounding and Bonding for Electrical Systems."
3. Power Distribution: Readily accessible panelboard in accordance with Section 262416 "Panelboards" installed at [**interior**][**exterior**] location[**coordinated with Architect**]. Include 25 percent provisions for installation of additional future devices, as directed by the Owner.
4. Power Connections:

    a. [**One**] duplex, weatherproof, ground-fault circuit interrupter (GFCI), NEMA 5-15R power outlet(s) for servicing exterior equipment.
    b. [**One**][**Two**] duplex, [**ground-fault circuit interrupter (GFCI),**] NEMA 5-15R power outlet(s) under counter(s) near access openings.
    c. [**One**][**Two**] Type USB-A power outlet(s) above counter(s) for charging portable devices.
    d. Provide power connections and means of disconnect for interior and exterior HVAC equipment.
    e. Provide power connections and means of disconnect for vehicle[**and pedestrian**] control equipment.

5. Lighting:

    a. Booth Interior: LED. Provide 20-fc (200-lux) average horizontal illuminance, with uniformity not exceeding 2:1 average-to-minimum[dimmable from 100 percent to 10 percent,] on counter work surfaces.
    b. Booth Exterior: LED, located above door. Provide not less than **0.5-fc (5-lux)** average horizontal illuminance, with uniformity not exceeding 3:1 maximum-to-minimum, when measured at finished grade over the distance of **15 ft. (4.5 m)** from entrance door.
    c. Vehicle and Pedestrian Circulation:

        1) LZ1: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **2-fc (20-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1.5-fc (15-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        2) LZ2: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1.5-fc (15-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1-fc (10-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        3) LZ3: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1-fc (10-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.8-fc (8-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        4) LZ4: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **0.8-fc (8-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.6-fc (6-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.

    d. Controls: [**Provide manual switches for interior and exterior lighting on wall inside booth door**][**Provide automatic photocontrol for interior and exterior lighting, with**

manual override located on wall inside booth door].

N. Communications:

1. [**One**] communications outlet(s) under counter(s) with [**two**][**four**] TIA-1096-A miniature eight-position series jack(s) for connecting telephone and data equipment.

O. Heating Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled, [**110-V**][**230/208-V**], electric heater with fan-forced operation and with capacity of not less than [**5000 Btu/h (1470 W)**][**7500 Btu/h (2200 W)**]. Enclose in enameled-steel cabinet[**and mount under work counter**].

P. Cooling Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled air conditioner with cooling capacity of not less than [**10,000 Btu/h (2930 W)**][**12,000 Btu/h (3520 W)**][**13,500 Btu/h (3960 W)**]. Enclose in enameled-steel cabinet.

Q. Accessories: Provide the following for each control booth:

1. Through-wall transaction drawers[**and speaking apertures**].
2. Antifatigue mats.
3. Exterior stainless steel counter.
4. [**Floor**][**Wall-mounted**] safe.
5. Ventilation fan.
6. Insect screens on operable openings.
7. Rollup shutters on doors and windows.
8. Intercom.
9. Traffic control lights.
10. Bollards.

R. Anchorage: [**Cast-in-place anchor bolts**][**Postinstalled anchors**] fabricated from non-ferrous or corrosion-resistant materials, with allowable load or strength design greater than or equal to the design load, as determined by testing conducted by a qualified testing agency.

S. Materials:

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, commercial quality, **G90 (Z275)** coating designation; mill phosphatized.
2. Galvanized Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D); hot-dip galvanized in accordance with ASTM A123/A123M.
3. Steel Structural Tubing: ASTM A500/A500M, Grade B.
4. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
5. Steel Mechanical Tubing: ASTM A513/A513M, welded-steel mechanical tubing.
6. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized in accordance with ASTM A123/A123M.
7. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

    a. Sheet: ASTM B209/B209M.
    b. Extruded Shapes: **ASTM B221 (ASTM B221M)**.
    c. Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T4 or Alloy 6061-T6.

8. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
9. Plastic Laminate: ISO 4586-3, Grade HGS or HGL.
10. Plywood: DOC PS 1, Exterior grade.
11. Particleboard: ANSI A208.1, Grade M-2.
12. Clear Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, and Quality

q3; [**6 mm thick**].

13. Clear Insulating Glass: ASTM E2190. Factory-assembled units consisting of two lites of 2.5-mm-thick clear float glass, ASTM C1036, Type I, Class 1, Quality q3, and dehydrated air space, with a total overall unit thickness of [**1 inch (25 mm)**][**3/4 inch (19 mm)**][**5/8 inch (16 mm)**] and with manufacturer's standard dual seal. Provide tempered lites where indicated.
14. Ballistic-Resistant Glazing: Tested to comply with bullet-resistant testing level indicated.

T. Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply with coating manufacturer's written instructions for applying and baking.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 FABRICATED ALUMINUM CONTROL BOOTHS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Modular Building Systems, Inc.**]
2. [**Austin Mohawk and Company, Inc.**]
3. [**Keystone Structures, Inc.**]
4. [**Mardan Fabrication, Inc.**]
5. [**NRB Modular Solutions Inc.**]
6. [**Porta-King Building Systems; a division of Jay Henges Enterprises, Inc.**]
7. [**Portafab Corporation**]
8. [**Starrco**]

B. Building Style: [**Standard square corners**][**Radius corners**][**Round corners**][**Butt-glazed corners**][**Wraparound type, with single rounded building end**][**Wraparound type, with both building ends rounded**][**As indicated on Drawings**].

C. Structural Framework: Fabricated from **2-by-2-by-0.125-inch (51-by-51-by-3.18-mm)** aluminum tubing, channel, angle, or tee extrusions; with [**clear**][**color**] anodic finish. Connect framework with[**exposed**] mechanical fasteners.

D. Sliding Doors: Top suspended from aluminum track with ball-bearing rollers; **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from clear-anodized aluminum; with [**top half**][**full height**] of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping. Provide door on [**one side**][**both sides**] of booth.

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**] glass.
2. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.

E. Swinging Doors: **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from clear-anodized aluminum; with [**top half**][**full height**] of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.[**Provide door on back of booth.**]

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**] glass.
2. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.

F. Windows: Extruded-aluminum sash frames glazed with clear [**tempered**][**insulating**] glass.

1. Frame Finish: Manufacturer's standard mill or clear anodic.
2. Operable Windows: Equip windows with cam locks, weather stripping, and [**stainless steel**][**nylon**] ball-bearing rollers.
3. Screens: [**Insect**][**Security**] screens for each window.
4. Corner Shape: [**Square**][**Round**].

G. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from [0.032-inch- (0.81-mm-)][0.063-inch- (1.60-mm-)] thick aluminum sheet, and interior face panel fabricated from [0.032-inch- (0.81-mm-)][0.050-inch- (1.27-mm-)] thick aluminum sheet; with 2-inch- (51-mm-) thick [polystyrene][polyisocyanurate board insulation] in cavity between exterior and interior face panels.

H. Raised Base Assembly: **4-inch- (102-mm-)** high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from **2-by-4-by-0.125-inch (51-by-102-by-3.18-mm)** aluminum tubing or aluminum angles. Include anchor clips fabricated from **1/4-inch- (6-mm-)** thick aluminum, predrilled and welded to exterior of integral floor frame.

1. Insulated Floor Assembly: Assembly consisting of **0.032-inch- (0.81-mm-)** thick, aluminum sheet underside with plywood and rigid insulation core; covered by **0.125-inch- (3.18-mm-)** thick, aluminum rolled tread plate; with overall assembly thickness of **2 inches (51 mm)**.
2. Uninsulated Floor Assembly: Assembly consisting of [**one**][**two**] layer(s) of **3/4-inch- (19-mm-)** thick plywood or oriented strand board with [**0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate**][**vinyl composition flooring**][**carpeting**].

I. Open Base: No perimeter frame, with surface of supporting concrete base as finished floor.

J. Flat Roof/Ceiling Assembly: Assembly consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.

1. Exterior Roof Panel: Fabricated from **0.032-inch- (0.81-mm-)** thick aluminum sheet; with protective plastic sheet finish and full-perimeter gutter.
2. Interior Ceiling Panel: Fabricated from **0.125-inch- (3.18-mm-)** thick hardboard; with polyisocyanurate board insulation in cavity between ceiling and roof.
3. Insulated Composite Panel: Fabricated from **0.032-inch- (0.81-mm-)** thick aluminum sheet faces and expanded-foam insulation core.
4. Canopy Fascia: Fabricated from **0.063-inch- (1.60-mm-)** thick aluminum sheet, of [**manufacturer's standard design**][**custom design indicated on Drawings**].
    a. Height: [**6 inches (152 mm)**][**8 inches (203 mm)**].
    b. Configuration:
        1) Overhang [**3 inches (76 mm)**] beyond face of walls below.
        2) Flush with face of walls below.
5. Downspouts: Integral, extending **3 inches (76 mm)** beyond booth walls.
6. Roof scuppers.
7. Rooftop finial.

K. Work Counters: Full width of control booth, reinforced; with **16-inch- (406-mm-)** wide [**storage**][**cash**] drawer below each counter and an access opening for electrical cords at[**each**] rear corner of counter.

1. Material: **1/2-inch- (13-mm-)** thick particleboard with plastic-laminate finish.
2. Depth: [**18 inches (457 mm)**][**20 inches (508 mm)**][**22 inches (559 mm)**].

L. Electrical Power Service:

1. Single-Point Connection: Service-entrance-rated, fused safety switch located on exterior for connection of 125 A, [**120/240 V, single-phase, three-wire**][**120/208 V, single-phase, three-wire**][**208Y/120 V, three-phase, four-wire**] feeder with equipment ground conductor.
2. Grounding: Grounding electrode bonded to equipment ground conductor at single-point connection in accordance with NFPA 70 and Section 260526 "Grounding and Bonding for Electrical Systems."
3. Power Distribution: Readily accessible panelboard in accordance with Section 262416 "Panelboards" installed at [**interior**][**exterior**] location[**coordinated with Architect**]. Include 25 percent provisions for installation of additional future devices, as directed by the Owner.
4. Power Connections:

    a. [**One**] duplex, weatherproof, ground-fault circuit interrupter (GFCI), NEMA 5-15R power outlet(s) for servicing exterior equipment.
    b. [**One**][**Two**] duplex, [**ground-fault circuit interrupter (GFCI),**] NEMA 5-15R power outlet(s) under counter(s) near access openings.
    c. [**One**][**Two**] type USB-A power outlet(s) above counter(s) for charging portable devices.
    d. Provide power connections and means of disconnect for interior and exterior HVAC equipment.
    e. Provide power connections and means of disconnect for vehicle[**and pedestrian**] control equipment.

5. Lighting:

    a. Booth Interior: LED. Provide 20-fc (200-lux) average horizontal illuminance, with uniformity not exceeding 2:1 average-to-minimum[dimmable from 100 percent to 10 percent,] on counter work surfaces.
    b. Booth Exterior: LED, located above door. Provide not less than **0.5-fc (5-lux)** average horizontal illuminance, with uniformity not exceeding 3:1 maximum-to-minimum, when measured at finished grade over the distance of **15 ft. (4.5 m)** from entrance door.
    c. Vehicle and Pedestrian Circulation:

        1) LZ1: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **2-fc (20-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1.5-fc (15-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        2) LZ2: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1.5-fc (15-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1-fc (10-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        3) LZ3: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1-fc (10-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.8-fc (8-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        4) LZ4: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **0.8-fc (8-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.6-fc (6-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.

d. Controls: [**Provide manual switches for interior and exterior lighting on wall inside booth door**][**Provide automatic photocontrol for interior and exterior lighting, with manual override located on wall inside booth door**].

M. Communications:

1. [**One**] communications outlet(s) under counter(s) with [**two**][**four**] TIA-1096-A miniature eight-position series jack(s) for connecting telephone and data equipment.

N. Heating Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled, [**110-V**][**230/208-V**] electric heater with fan-forced operation and with capacity of not less than [**5000 Btu/h (1470 W)**][**7500 Btu/h (2200 W)**]. Enclose in enameled-steel cabinet[**and mount under work counter**].

O. Cooling Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled air conditioner with cooling capacity of not less than [**10,000 Btu/h (2930 W)**][**12,000 Btu/h (3520 W)**][**13,500 Btu/h (3960 W)**]. Enclose in enameled-steel cabinet.

P. Accessories: Provide the following for each control booth:

1. Through-wall transaction drawers[**and speaking apertures**].
2. Antifatigue mats.
3. Exterior stainless steel counter.
4. [**Floor**][**Wall-mounted**] safe.
5. Ventilation fan.
6. Insect screens on operable openings.
7. Rollup shutters on doors and windows.
8. Intercom.
9. Traffic control lights.
10. Bollards.

Q. Anchorage: [**Cast-in-place anchor bolts**][**Postinstalled anchors**] fabricated from stainless steel, with allowable load or strength design greater than or equal to the design load, as determined by testing conducted by a qualified testing agency.

R. Materials:

1. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

a. Sheet: ASTM B209/B209M.
b. Extruded Shapes: **ASTM B221 (ASTM B221M)**.
c. Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T4 or Alloy 6061-T6.

2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
3. Plastic Laminate: ISO 4586-3, Grade HGS or HGL.
4. Plywood: DOC PS 1, Exterior grade.
5. Particleboard: ANSI A208.1, Grade M-2.
6. Clear Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, and Quality q3; [**6 mm thick**].
7. Clear Insulating Glass: ASTM E2190. Factory-assembled units consisting of two lites of 2.5-mm-thick clear float glass, ASTM C1036, Type I, Class 1, Quality q3, and dehydrated air space, with a total overall unit thickness of [**1 inch (25 mm)**][**3/4 inch (19 mm)**][**5/8 inch (16 mm)**] and with manufacturer's standard dual seal. Provide tempered lites where indicated.
8. Ballistic-Resistant Glazing: Tested to comply with bullet-resistant testing level indicated.

S. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

T. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

U. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 FABRICATION

A. Factory fabricate complete control booths, with accessories and options installed at factory.

B. Factory preglaze windows and doors.

C. Factory prewire control booths, ready for connection to service at Project site.

D. Fabricate control booths with [**forklift pockets in base of booth**][**removable lifting eye centered in roof**].

E. Accessible Control Booths: Where indicated to be accessible, fabricate control booths as follows:

1. Provide service windows located no higher than **34 inches (865 mm)** above exterior grade.
2. Provide door opening with minimum **32-inch (813-mm)** clear width.
3. Provide minimum **60-inch (1525-mm)** clear turning spacing within the booth.
4. Provide minimum **27-inch (685-mm)** clearance beneath interior work surfaces. Locate work surfaces **28 inches (710 mm)** minimum and **34 inches (865 mm)** maximum above the floor.
5. Locate controls and operable parts no lower than **15 inches (381 mm)** and no higher than **48 inches (1219 mm)** above the floor where reach is unobstructed. Where side reach is obstructed, locate controls and operable parts no lower than **15 inches (381 mm)** and no higher than **46 inches (1170 mm)** above the floor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including concrete bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before control booth installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install control booths in accordance with manufacturer's written instructions.

B. Accessible Control Booths: Install with interior floor surface at same elevation as adjacent paved surfaces.

C. Set control booths plumb and aligned. Level baseplates true to plane, with full bearing on concrete bases.

D. Fasten control booths securely to concrete base with anchorage indicated.

E. Connect to electrical power service and communication systems.

F. Perform startup checks of [**heating**][**and**][**cooling**] units in accordance with manufacturer's written instructions.

3.3 ADJUSTING

A. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.

B. Adjust interior and exterior lighting controls.

C. Lubricate hardware and other moving parts.

D. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 13 34 23 16

Task	Specification	Specification Description
13 34 23 16	11 12 00 00	Parking Control Equipment
13 34 23 31	13 34 19 00	Metal Building Systems
13 34 23 31	13 34 23 16	Fabricated Control Booths
13 42 63 16	11 97 26 00a	Detention Furniture

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SECTION 13 46 13 00 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Lightning protection system for ordinary structures.

B. Section Includes: Lightning protection system for the following:

1. Ordinary structures.
2. <**Insert one or more miscellaneous structures or special occupancies**>.

1.2 ACTION SUBMITTALS

A. Product Data: For each product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
    b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. [**UL Master Label Certificate**][**UL Letter of Findings Limited Scope Inspection Report**][**LPI Master Certificate**][**LPI Limited Scope Certification**].

1.5 QUALITY ASSURANCE

A. Installer Qualifications: [**UL-listed installer, category OWAY**][**or**][**LPI Master Installer**].

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION FOR STRUCTURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**allG Fabrication (formerly ALT)**]
2. [**East Coast Lightning Equipment Inc.**]
3. [**ERICO; brand of nVent Electrical plc**]
4. [**Harger Lightning & Grounding; business of Harger, Inc.**]
5. [**Heary Bros. Lightning Protection Co. Inc**]
6. [**Independent Protection Co**]
7. [**National Lightning Protection**]
8. [**Preferred Lightning Protection**]
9. [**Robbins Lightning, Inc**]
10. [**Thompson Lightning Protection, Inc**]
11. [**VFC Lightning Protection**]
12. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**allG Fabrication (formerly ALT)**]
2. [**East Coast Lightning Equipment Inc.**]
3. [**ERICO; brand of nVent Electrical plc**]
4. [**Harger Lightning & Grounding; business of Harger, Inc.**]
5. [**Heary Bros. Lightning Protection Co. Inc**]
6. [**Independent Protection Co**]
7. [**National Lightning Protection**]
8. [**Preferred Lightning Protection**]
9. [**Robbins Lightning, Inc**]
10. [**Thompson Lightning Protection, Inc**]

11. [**VFC Lightning Protection**]
12. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for [**Class I**][**Class II**] buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for [**Class I**][**Class II**] buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. [**Copper**][**Stainless steel**][**or**][**Aluminum**] unless otherwise indicated.
2. [**3/8-inch (10-mm)**][**1/2-inch (12.7-mm)**][**5/8-inch (16-mm)**] diameter by [**10 inches (254 mm)**][**12 inches (305 mm)**][**15 inches (380 mm)**][**18 inches (450 mm)**][**24 inches (610 mm)**]<**Insert length of air terminal**> long.
3. [**Pointed**][**Rounded**] tip.
4. [**Integral base support**][**Threaded base support**].

B. Air Terminal Bracing:

1. [**Aluminum**][**Copper**][**Stainless steel**][**Galvanized steel**].
2. [**1/4-inch (6-mm)**]<**Insert size**> diameter rod.

C. Class I Main Conductors:

1. [**Stranded Copper: 57,400 circular mils in diameter**][**Aluminum: 98,600 circular mils in diameter**].

D. Class II Main Conductors:

1. [**Stranded Copper: 115,000 circular mils in diameter**][**Aluminum: 192,000 circular mils in diameter**].

E. Secondary Conductors:

1. [**Stranded Copper: 26,240 circular mils in diameter**][**Aluminum: 41,400 circular mils in diameter**].

F. Ground Loop Conductor: [**Stranded copper**][**Tinned copper**].

G. Ground Rods:

1. Material: [**Solid copper**][**Copper-clad steel**][**Stainless steel**].
2. Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**].
3. Rods shall be not less than **120 inches (3050 mm)** long.
4. [**Sectional type, with integral threads**].

H. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to [**UL 96A**][**NFPA 780**].

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and **8 inches (203 mm)** in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within **200 feet (60 m)** of building. Comply with requirements for [**concealed installations in UL 96A**][**concealed systems in NFPA 780**].

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: [**bolted connectors**][**exothermic weld**][**high compression**][**crimp**].

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.

END OF SECTION 13 46 13 00

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SECTION 13 47 13 00 - CATHODIC PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Magnesium anodes, Type II.
2. Magnesium/manganese alloy anodes.
3. Zinc anodes for buried service, Type Z-1.
4. Permanent reference electrodes.
5. Wire and cable.
6. Test stations.
7. Sealing, potting, and dielectric compounds.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design, supervise, test, and inspect the installation of cathodic protection systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Design cathodic protection for pipelines in accordance with NACE RP0169.
2. Design cathodic protection for metal underground storage tanks in accordance with NACE RP0285.

B. Survey site and determine soil or water corrosivity (resistivity), current requirements, potential surveys, stray currents, and water chemistry/corrosivity (pH).

C. Select anodes and accessories relevant to level of protection. Design anodes for an estimated life of [**15**][**30**] years before replacement.

D. Cathodic protection systems provide protective potential that complies with referenced NACE standards. Insulators are required if needed to insulate protected metals from other structures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For cathodic protection. Include plans, evaluations, sections, details, and attachments to other work.

1. Detail locations of cathodic protection equipment, devices, and outlets, with characteristics and cross-references to products.
2. Include calculations and details of anode designs.
3. Include labeling and identifying scheme for wires, cables, and test boxes.

C. Delegated Design Submittals: For cathodic protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified corrosion engineer responsible for their preparation.

1. Conduct site tests necessary for design, including soil resistivity, close-interval potential surveys, testing during construction, interference testing, and training of the Owner's personnel.
2. Provide system design calculations, stating the maximum recommended anode current output density, and the rate of gaseous production, if any, at that current density.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, and coordinating connections to [**piping**][**and**][**tanks**].

B. Professional Engineer Qualification Data: Submit evidence of current license, corporate authorization (if applicable) of the engineering business, and NACE certifications.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Basic system operation, outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown.
2. Instructions for pipe-to-reference cell and tank-to-reference cell potential measurements and frequency of monitoring.
3. Instructions for dielectric connections, interference and sacrificial-anode bonds; and precautions to ensure safe conditions during repair of pipe, tank or other metallic systems. Instructions are to be neatly bound.
4. Locations of all anodes, test stations, and insulating joints.
5. Structure-to-reference cell potentials as measured during the tests required by "Field Quality Control" Article.
6. Recommendations for maintenance testing, including instructions for pipe-to-reference cell potential measurements and frequency of testing.
7. Precautions to ensure safe conditions during repair of pipe system.

1.6 QUALITY ASSURANCE

A. Corrosion Engineer Qualifications: A qualified professional engineer who has education and experience in cathodic protection of buried and submerged metal structures and has NACE accreditation or certification as a Corrosion Specialist or Cathodic Protection Specialist.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect anodes from exposure to rain and direct sunlight.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace permanent reference electrodes that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**15**][**30**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MAGNESIUM ANODES, TYPE II

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Corrpro Companies, Inc.**]
2. [**Cott Manufacturing Company**]
3. [**CPMasters, Inc.**]
4. [**ELTECH Systems Corporation USA**]
5. [**Farwest Corrosion Control Company**]
6. [**Loresco International**]
7. [**MATCOR**]

B. Comply with ASTM B843.

C. Chemical composition as percent of weight is to be as follows:

1. Aluminum: 0.010 maximum.
2. Manganese: 0.50 to 1.3.
3. Zinc: 0.05 maximum.
4. Silicon: 0.50 maximum.
5. Copper: 0.02 maximum.
6. Nickel: 0.001 maximum.
7. Iron: 0.03 maximum.
8. Other Impurities: 0.05 each; 0.3 maximum total.
9. Magnesium: Remainder.

D. Anode Core: Galvanized steel with anode wire silver-soldered to the core. Connection is to be recessed and epoxy insulated for 600-V rating. Connection is to be covered with heat-shrinkable tubing, and insulation is to be extended over connection.

E. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation in accordance with ASTM D1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.

F. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes are to be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material is to have the following chemical composition by weight:

1. Hydrated Gypsum: 75 percent.
2. Bentonite Clay: 20 percent.
3. Anhydrous Sodium Sulfate: 5 percent.

2.2 MAGNESIUM/MANGANESE ALLOY ANODES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Corrpro Companies, Inc.**]
2. [**Cott Manufacturing Company**]
3. [**CPMasters, Inc.**]
4. [**ELTECH Systems Corporation USA**]
5. [**Farwest Corrosion Control Company**]
6. [**Loresco International**]
7. [**MATCOR**]

B. Chemical composition as percent of weight is to be as follows:

1. Aluminum: 0.01 maximum.
2. Manganese: 0.50 to 1.3.
3. Copper: 0.02 maximum.
4. Nickel: 0.001 maximum.
5. Iron: 0.03 maximum.
6. Other Impurities: 0.05 each; 0.3 maximum total.
7. Magnesium: Remainder.

C. Bare Anode Weight: **40 lb (18 kg)**, not including core, and a nominal length of **60 inches (1520 mm)**.

D. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation in accordance with ASTM D1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.

E. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes are to be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material is to have the following chemical composition by weight:

1. Hydrated Gypsum: 75 percent.
2. Bentonite Clay: 20 percent.
3. Anhydrous Sodium Sulfate: 5 percent.

2.3 ZINC ANODES FOR BURIED SERVICE, TYPE Z-1

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Corrpro Companies, Inc.**]
2. [**Cott Manufacturing Company**]
3. [**CPMasters, Inc.**]
4. [**ELTECH Systems Corporation USA**]
5. [**Farwest Corrosion Control Company**]
6. [**Loresco International**]
7. [**MATCOR**]

B. Comply with ASTM B418, Type II.

C. Chemical composition as percent of weight is to be as follows:

1. Aluminum: 0.005 maximum.

2. Cadmium: 0.003 maximum.
3. Iron: 0.0014 maximum.
4. Zinc: Remainder.

D. Bare Anode Ingot Weight: **30 lb (13.6 kg)**, **2 inches (50 mm)** square and **30 inches (760 mm)** long. Packaged weight of anode bag is to be **70 lb (32 kg)**.

E. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation in accordance with ASTM D1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.

F. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes are to be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material is to have the following chemical composition by weight:

1. Hydrated Gypsum: 75 percent.
2. Bentonite Clay: 20 percent.
3. Anhydrous Sodium Sulfate: 5 percent.

2.4 PERMANENT REFERENCE ELECTRODES

A. [**Copper/copper sulfate (Cu/CuSO4)**], suitable for direct burial. Electrode is to be guaranteed by supplier for [**15**][**30**] years' service in the installed environment.

2.5 WIRE AND CABLE

A. Anode Header Cable: Single-conductor, Type HMWPE, insulated cable specifically designed for direct-buried dc service in cathodic protection installations.

1. Conductor: Stranded, annealed, uncoated copper, not less than No. 8 AWG, complying with ASTM B3 and ASTM B8.
2. Insulation: High-molecular-weight polyethylene, complying with NEMA WC 70/ICEA S-95-658.
3. Minimum Average Thickness of Insulation: **110 mils (2.8 mm)** for Nos. 8 through 2 AWG, and **125 mils (3.2 mm)** for Nos. 1 through 4/0 AWG; rated at 600 V.
4. Connectors: [Copper-compression type][exothermic welds].

B. Conductors and Cables: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Bonding Conductors for Joint and Continuity Bonds: Not less than No. 8 AWG, stranded, Type THWN copper conductors.
2. Flexible Pipe Coupling Bonds: Flexible copper straps with electrical resistance equal to No. 1/0 AWG stranded copper wire and with five holes for five exothermic welds to pipe.
3. Test Wires: No. 12 AWG, Type THWN copper conductors.
4. Resistance Wires: No. 16 or No. 22 AWG nickel-chromium wire.
5. Cables for Installation in Conduit: Type THWN copper conductors.

2.6 TEST STATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Corrpro Companies, Inc.**]
2. [**Cott Manufacturing Company**]
3. [**CPMasters, Inc.**]

B. Plastic Test Stations: Flush-mounted type, manufactured of high-impact-resistant PVC or polycarbonate with watertight conduit connections and cover and removable terminal board having at least five terminals.

C. Test Station Mounting Enclosures:

1. Non-Traffic-Area Boxes: Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
2. Traffic-Area Boxes: Comply with requirements in Section 260543 "Underground Ducts and Raceways for Electrical Systems." Boxes are to have cast-iron covers with a welded bead legend "CP TEST."

2.7 SEALING, POTTING, AND DIELECTRIC COMPOUNDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**Chase Corporation - Chase Specialty Coatings**]
3. [**Farwest Corrosion Control Company**]

B. Sealing and Dielectric Insulating Compound: Comply with NACE RP0188. Black, rubber based, soft, permanently pliable, tacky, moldable, and unbacked; [**0.125 inch (3 mm)**][**0.5 inch (13 mm)**] thick.

C. Potting Compound: Comply with NACE RP0188. Cast-epoxy, two-package type; fabricated for this purpose and covered with heat-shrinkable tape.

D. Pressure-Sensitive, Vinyl-Plastic Electrical Tape: Comply with UL 510.

2.8 EXOTHERMIC WELDING MATERIALS

A. Exothermic Weld Kits: Specifically designed by manufacturer for welding materials and shapes required.

B. Exothermic Weld Caps: Dome of high-density polyethylene, **10-mil (0.254-mm)** minimum thickness, filled with mastic and containing a tunnel portion to separate lead wire from exothermic weld.

2.9 COATING REPAIR MATERIALS

A. Touchup Coating Materials: Comply with requirements in Section 099600 "High-Performance Coatings" for coating systems for touchup of factory-applied coatings.

B. Adhesive-Applied Coating Materials: Coating materials are to be compatible with factory-applied coating system.

1. Nominal thickness of coating materials is to be not less than [**8 mils (0.2 mm)**][**16 mils (0.4 mm)**][**24 mils (0.6 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**], plus or minus 5 percent.

2. Coating materials are to be one of the following supplied by factory-applied coating system manufacturer:

   a. Polyvinyl-chloride, pressure-sensitive, adhesive tape.
   b. High-density polyethylene/bituminous rubber compound tape.
   c. Butyl rubber tape.
   d. Coal-tar epoxy.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS, GENERAL

A. Comply with ANSI/IEEE C2 and NFPA 70.

B. Make connections to ferrous pipe[**and metal tanks**] using exothermic welding.

C. Coat welds with the coating repair material and apply an exothermic weld cap.

3.2 INSTALLATION OF MAGNESIUM ANODES, TYPE II

A. Install magnesium anodes at locations that clear obstructions. Install at least **36 inches (900 mm)** and no more than **10 feet (3 m)** from pipe[**or tank**] to be protected. Install in augered holes with top of anode [**24 inches (600 mm) below pipe invert elevation**][**a minimum of 36 inches (900 mm) below finished grade**]. In soils that will collapse into augered holes, use casing of galvanized sheet steel.

B. Install anodes in a dry condition after plastic or waterproof protective covering has been completely removed from water-permeable permanent container that houses anode metal. Do not use anode-connecting wire for lowering anode into hole. Backfill annular space around anode with fine earth in **6-inch (150-mm)** layers; compact each layer using hand tools. Do not strike anode or connecting wire during backfilling and compacting. After backfilling and compacting to within **6 inches (150 mm)** of finished grade, pour approximately **5 gal. (20 L)** of water into each filled hole. After water has been absorbed by earth, complete backfilling to finished level.

C. If rock strata are encountered before achieving specified augured hole depth, install anodes horizontally at depth at least as deep as bottom of pipe to be protected.

D. Install anodes spaced as indicated, [**directly connected**][**connected through a test station**] to the pipeline, allowing slack in connecting wire to compensate for movement during backfill operation.

E. For tank protection, connect groups of anodes to collector cable. Make contact, through a test station, with tank to be protected.

F. Do not use resistance wires to reduce current output of individual or group anodes.

3.3 INSTALLATION OF MAGNESIUM/MANGANESE ALLOY ANODES

A. Install magnesium anodes at locations that clear obstructions. Install at least **36 inches (900 mm)** and no more than **10 feet (3 m)** from pipe[**or tank**] to be protected. Install in augered holes with top of anode [**24 inches (600 mm) below pipe invert elevation**][**a minimum of 36 inches (900 mm) below finished grade**]. In soils that will collapse into augered holes, use casing of galvanized sheet steel.

B. Install anodes in a dry condition after plastic or waterproof protective covering has been completely removed from water-permeable permanent container that houses anode metal. Do not use anode-connecting wire for lowering anode into hole. Backfill annular space around anode with fine earth in **6-inch (150-mm)** layers; compact each layer using hand tools. Do not strike anode or connecting wire during backfilling and compacting. After backfilling and compacting to within **6 inches (150 mm)** of finished grade, pour approximately **5 gal. (20 L)** of water into each filled hole. After water has been absorbed by earth, complete backfilling to finished level.

C. If rock strata are encountered before achieving specified augured hole depth, install anodes horizontally at depth at least as deep as bottom of pipe to be protected.

D. Install anodes spaced as indicated, [**directly connected**][**connected through a test station**] to the pipeline, allowing slack in connecting wire to compensate for movement during backfill operation.

E. For tank protection, connect groups of anodes to collector cable. Make contact, through a test station, with tank to be protected.

F. Do not use resistance wires to reduce current output of individual or group anodes.

3.4 INSTALLATION OF ZINC ANODES FOR BURIED SERVICE, TYPE Z-1

A. Install zinc anode horizontally in a hole at least **3 inches (76 mm)** larger than anode. Install anode under new copper water tubing, including service lines, blowoffs, and air releases. Separate piping and anode by at least **24 inches (600 mm)**, but not more than **60 inches (1520 mm)**.

B. Install anode midway between both ends of piping. Install anode wire in piping trench and connect to piping at an accessible location. Install anode wire in PVC conduit where rising out of the ground to the aboveground connection.

3.5 INSTALLATION OF PERMANENT REFERENCE ELECTRODES

A. Install directly beneath the buried metallic component being protected.

3.6 INSTALLATION OF WIRE AND CABLE

A. Install conductors, except anode wires, in PVC conduit with waterproof PVC junction boxes. Comply with requirements in Section 260533.13 "Conduit for Electrical Systems" for conduit and its installation.

B. Anode Wire Installation: Cover trench bottom for the anode wire with **3-inch (76-mm)** layer of sand or stone-free earth. Center wire on backfill layer and do not stretch or kink the conductor. Place backfill over wire in layers not exceeding **6 inches (150 mm)** deep, and compact each layer. Use clean fill, free from roots, vegetable matter, and refuse. Place cable underground-line warning tape within **18 inches (460 mm)** of finished grade, above cable and conduit.

C. Bonding Conductors: Install conductors on metallic pipe and tanks, to and across buried flexible couplings, mechanical joints, and flanged joints except at places where insulating joints are specified. Welded and threaded joints are considered electrically continuous and do not require bonding.

1. Install at least two bonds between parts requiring bonding.
2. Bonding conductors must contain sufficient slack for anticipated movement between structures. Bonding conductors across pipe joints are to have not less than a **4-inch (100-mm)** slack for pipe

expansion, contraction, and soil stress.

3. Connect bonding conductors to pipe, coupling follower rings and coupling middle ring or sleeve. Connect bonding conductors with exothermic welds.

D. For wire splicing, use compression connectors or exothermic welds.

3.7 INSTALLATION OF TEST STATIONS

A. Install test stations as follows:

1. At **1000-foot (300-m)** intervals.
2. At insulating joints.
3. At both ends of casings when casing material is included in the cathodic protection system.
4. Where pipe crosses other metal pipes.
5. Where pipe connects to existing piping system.
6. Where pipe connects to dissimilar metal pipe.
7. At each tank component.

B. Install test stations on backfill complying with requirements for trench bottom fill for anode wires unless otherwise indicated.

C. Terminate test conductors on terminal boards and install a spare set of test leads at each testing location.

3.8 INSTALLATION OF PIPE JOINTS

A. Insulating Flange Sets: Cover flanges with sealing and dielectric compound.

B. Insulating Unions: Install electrical isolation at each building entrance and at other locations indicated on approved Delegated Design Drawings. Cover unions with sealing and dielectric compound.

3.9 INSTALLATION OF INSULATING PIPE SLEEVES

A. Install insulating sleeves between metallic piping and metal buildings, hangers, supports, and other metal structures. Completely surround the metallic pipe for the full length of the steel contact and effectively prevent contact between the cathodically protected metallic pipe and other metallic structures. Support insulating sleeve to prevent damage to coating and to accommodate relative movement, vibrations, and temperature differentials.

3.10 DISSIMILAR METALS

A. Underground Dissimilar Piping: Coat insulating joint and pipe at joints of dissimilar piping material with sealing and dielectric compound for a minimum distance of 10 pipe diameters on both sides of joint.

B. Underground Dissimilar Valves: Coat dissimilar ferrous valves and pipe with sealing and dielectric compound for a minimum distance of 10 pipe diameters on both sides of valve.

C. Aboveground Dissimilar Pipe and Valves: If dissimilar metal pipe joints and valves are not buried and are exposed only to atmosphere, coat connection or valve, including pipe, with sealing and dielectric compound for a minimum distance of three pipe diameters on both sides of junction.

3.11 COATINGS

A. Field Joints: Apply adhesive-applied coating system in a thickness to achieve corrosion protection equal to adjacent factory-applied coating.

3.12 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify anode wires and anode header cables with marker tape.
2. Identify underground wires and cables with underground-line warning tape.
3. Identify text boxes with engraved, laminated acrylic or melamine label, permanently attached to text box.

3.13 FIELD QUALITY CONTROL

A. Comply with NACE RP0169 and NACE RP0285.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Tests and Inspections: Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Static Pull Test: Choose, at random, one completed anode of each type for this destructive test. Demonstrate that anode wire connections have enough strength to withstand a minimum tensile load of **300 lb (136 kg)**. If test fails, replace all anodes and repeat test at another randomly selected anode.
2. Insulation Testing: Before anode system is connected to [**pipe**][**and**][**tank**], test insulation at each insulating joint and fitting. Demonstrate that no metallic contact, or short circuit, exists between the two insulated sections of [**pipe**][**and**][**tank**]. Replace defective joints or fittings.
3. Bonding Tests: Test for electrical continuity across all bonded joints. Repair or add additional bonds until electrical continuity is achieved.
4. Baseline Potentials: After backfilling of [**pipe and**][**pipe, tank, and**] anodes is completed, but before anodes are connected to [**pipe**][**and**][**tank**], measure the static potential of [**pipe**][**and**][**tank**] to soil. Record initial measurements.
5. Anode Output: Measure electrical current as anodes or groups of anodes are connected to [**pipe**][**and**][**tank**]. Use a low-resistance ammeter. Record current, date, time, and location of each measurement.
6. Reference Electrode Potential Measurements: On completion of installation of entire cathodic protection system, make electrode potential measurements of [**pipe**][**and**][**tank**] in accordance with NACE RP0169, using a copper/copper-sulfate reference electrode and a potentiometer-voltmeter, or a dc voltmeter with an internal resistance (sensitivity) of not less than 100,000 ohms per volt and a full scale of 1 or 2 V. Make measurements at same locations as those used for baseline potentials. Record voltage, date, time, and location of each measurement, using one of the following two methods:

a. 0.85 V Negative Voltage: With cathodic system in operation, measure a negative voltage of at least minus 0.85 V between [pipe][tank] and a saturated copper/copper-sulfate reference electrode contacting the earth directly over [pipe][tank].

b. 100-mV Polarization Voltage: Determine polarization voltage shift by interrupting protective current and measuring polarization decay. An immediate voltage shift will occur if protective current is interrupted. Use voltage reading, after immediate shift, as base reading from which to measure polarization decay. Measure at least a minimum polarization voltage shift of 100 mV between [pipe][tank] and a saturated copper/copper-sulfate reference electrode contacting the earth directly over [pipe][tank].

E. Location of Measurements for Piping: For coated piping or conduit, measure from reference electrode in contact with the earth directly over pipe. Measure at intervals not exceeding **400 feet (120 m)**. Make additional measurements at each distribution service riser, with reference electrode placed directly over service line.

F. Location of Measurements for Tanks: For underground tanks, measure from reference electrode located as follows:

1. Directly over center of tank.
2. At a point directly over tank and midway between each pair of anodes.
3. At each end of tank.

G. Interference Testing: Test interference with cathodic protection from any foreign [**pipes**][**and**][**tanks**] in cooperation with the Owner of foreign [**pipes**][**and**][**tanks**]. Report results and recommendations.

H. Stray Current Measurements: Perform at each test station. Mitigate stray currents due to lightning or overhead ac power transmission lines as provided for in NACE standards.

I. Inspect coatings; comply with NACE RP0188. Repair imperfections of factory-applied coatings as specified in "Coatings" Article.

1. Use electronic holiday detectors to detect coating imperfections.
2. All damage to the protective coating during transit and handling is to be repaired before installation.
3. Repair factory-applied coatings to have equal or better corrosion resistance than the factory-applied coating system. Field-repair material is to be of the type approved by, and is to be applied as recommended by, manufacturer of the coating material.

3.14 ADJUSTING

A. Adjust cathodic current using resistors as recommended by corrosion engineer who prepared the Delegated Design Submittal in Part 1.

B. During the first year after Substantial Completion, test, inspect, and adjust cathodic protection system every three months to ensure its continued compliance with specified requirements.

3.15 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain cathodic protection system.

END OF SECTION 13 47 13 00

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Task	Specification	Specification Description
13 47 13 13	13 47 13 00	Cathodic Protection
13 47 13 16	13 47 13 00	Cathodic Protection

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SECTION 13 49 00 00 - RADIATION PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lead sheet, strip, and plate.
2. Lead bricks.
3. Borated polyethylene sheets.
4. High-density concrete blocks.
5. Lead-lined gypsum board.
6. Lead-lined softwood plywood.
7. Lead glass.
8. Lead glazing plastic.
9. Lead-lined hollow-metal doors.
10. Lead-lined hollow-metal frames.
11. Lead-lined flush wood doors.
12. Lead-lined split-core wood doors.
13. Lead-lined modular shielding partitions.
14. Informational signs.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete floor topping over lead shielding in concrete slabs.
2. Section 055000 "Metal Fabrications" for steel framing members for bracing [**lead-brick**][**and**][**high-density concrete block**] wall shielding.

1.2 DEFINITIONS

A. Lead Equivalence: The thickness of lead that provides the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions.

1. Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV unless otherwise indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to radiation protection, including, but not limited to, the following:

a. Sequence and schedule of radiation protection work in relation to other work.
b. Supplementary lead shielding at duct, pipe, and conduit penetrations of radiation protection.
c. Methods of attaching other construction and equipment to lead-lined finishes.
d. Notification procedures for work that requires modifying radiation protection.

e. Requirements for field quality control.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Lead sheet, strip, and plate.
2. Lead bricks.
3. Borated polyethylene sheets.
4. High-density concrete blocks.
5. Lead-lined gypsum board.
6. Lead-lined softwood plywood.
7. Lead glass.
8. Lead glazing plastic.
9. Lead-lined hollow-metal doors.
10. Lead-lined hollow-metal frames.
11. Lead-lined flush wood doors.
12. Lead-lined split-core wood doors.
13. Lead-lined modular shielding partitions.
14. Informational signs.

B. Product Data Submittals:

1. Doors and Frames: Include construction details, material descriptions, core descriptions, [**fire-resistance ratings,**][**temperature-rise ratings,**] and finishes.

C. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
6. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
7. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

D. Shop Drawings: Show layout of radiation-protected areas, indicating lead thickness or lead equivalence of components. Show components and installation conditions not fully dimensioned or detailed in product data.

1. Show ducts, pipes, conduit, and other objects that penetrate radiation protection; include details of penetrations.
2. Show details of joints between radiation protection materials.
3. Show details of securing [**lead bricks**][**and**][**high-density concrete blocks**] to structure.
4. Include door details, including elevations, frame dimensions and profile, [**glazed light,**][**louver cutouts,**]and clearances and undercuts.

E. Samples: For units with factory-applied color finishes.

F. Product Schedule: For [**observation windows and**]doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For assemblies with radiation protection materials, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Miscellaneous metal members that support [**lead bricks**][**and**][**high-density concrete blocks**].
2. Items penetrating radiation protection materials, including the following:

a. Electrical services.
b. Air outlets and inlets.
c. Sprinklers.
d. Access panels.

B. Sample Warranty: For warranty.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Lead-Lined Gypsum Panels and Plywood: Store inside under cover, and keep dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

B. Lead-Lined, Hollow-Metal Doors and Frames: Comply with requirements in Section 081113 "Hollow Metal Doors and Frames" for delivery, storage, and handling.

C. Lead-Lined Wood Doors: Comply with requirements in Section 081416 "Flush Wood Doors" for delivery, storage, and handling.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install radiation protection until spaces are enclosed and

weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 WARRANTY

A. Warranty for Lead-Lined Wood Doors: Comply with requirements in Section 081416 "Flush Wood Doors."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of radiation protection product from single source from single manufacturer[**unless otherwise indicated**].

2.2 PERFORMANCE REQUIREMENTS

A. Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.

B. Materials, thicknesses, and configurations of radiation protection products indicated are based on radiation protection design prepared by the Owner's radiation health physicist. This design is available to Contractor upon request.

C. Lead-Lined Assemblies: Unless otherwise indicated, provide lead thickness in lead-lined assemblies of not less than lead thickness indicated for assemblies in which they are installed.

D. Lead Glazing: Unless otherwise indicated, provide lead equivalence of not less than that indicated for assembly in which glazing is installed.

E. Fire-Rated and Smoke-Control Door and Frame Assemblies: Comply with [**Section 081113 "Hollow Metal Doors and Frames"**][**and**][**Section 081416 "Flush Wood Doors"**].

2.3 LEAD SHEET, STRIP, AND PLATE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**ABM Lead Corporation**]
3. [**El Dorado Metals, Inc**]
4. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
5. [**Mayco Industries**]
6. [**MediRay**]
7. [**NELCO Worldwide**]
8. [**New Shield, Inc.**]

9. [**Pitts Little Corporation**]
10. [**Radiation Protection Products, Inc**]
11. [**Ray-Bar Engineering Corp**]
12. [**Ultraray Radiation Protection**]

B. Lead Sheet, Strip, and Plate: ASTM B749, Alloy UNS No. L51121 (chemical-copper lead).

2.4 LEAD BRICKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**ABM Lead Corporation**]
3. [**El Dorado Metals, Inc**]
4. [**Global Partners in Shielding, Inc.**]
5. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
6. [**Mayco Industries**]
7. [**MediRay**]
8. [**NELCO Worldwide**]
9. [**New Shield, Inc.**]
10. [**Pitts Little Corporation**]
11. [**Radiation Protection Products, Inc**]
12. [**Ray-Bar Engineering Corp**]
13. [**Ultraray Radiation Protection**]

B. Lead Bricks: Cast- or extruded-lead bricks with interlocking tongue and grooves or wedge-shape edges, made from pig lead complying with ASTM B29 with 0.5 percent antimony added.

2.5 BORATED POLYETHYLENE SHEETS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**Accurate Radiation Shielding, Inc.**]
3. [**El Dorado Metals, Inc**]
4. [**Global Partners in Shielding, Inc.**]
5. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
6. [**NELCO Worldwide**]
7. [**Pitts Little Corporation**]
8. [**Ultraray Radiation Protection**]

B. Borated Polyethylene Sheets: High-density polyethylene containing not less than [**5**][**30**] percent boron.

1. Color: [**As selected by Architect from manufacturer's standard selection**], as directed by the Owner.

2.6 HIGH-DENSITY CONCRETE BLOCKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**El Dorado Metals, Inc**]
2. [**Global Partners in Shielding, Inc.**]
3. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
4. [**Pitts Little Corporation**]
5. [**Ultraray Radiation Protection**]
6. [**Veritas Medical Solutions**]

B. High-Density Concrete Blocks: High-density cast concrete blocks with curved or wedge-shaped interlocking edges for dry-stack installation; [**145 lb/cu. ft. (2320 kg/cu. m)**][**250 lb/cu. ft. (4000 kg/cu. m)**][**300 lb/cu. ft. (4800 kg/cu. m)**] density.

2.7 LEAD-LINED GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**ABM Lead Corporation**]
3. [**Accurate Radiation Shielding, Inc.**]
4. [**El Dorado Metals, Inc**]
5. [**Global Partners in Shielding, Inc.**]
6. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
7. [**Mayco Industries**]
8. [**NELCO Worldwide**]
9. [**New Shield, Inc.**]
10. [**Pitts Little Corporation**]
11. [**Radiation Protection Products, Inc**]
12. [**Ray-Bar Engineering Corp**]
13. [**Ultraray Radiation Protection**]

B. Lead-Lined Gypsum Board: **5/8-inch- (15.9-mm-)** thick gypsum board complying with Section 092900 "Gypsum Board," of width and length required for support spacing and to prevent cracking during handling, and with a single sheet of lead laminated to the back of the board.

1. Lead Sheet Lining: Full width [**and length of board**][**of board and length necessary to extend from floor to 84 inches (2134 mm) above floor**][**of board and height as indicated on Drawings**].[**Extend lead sheet lining 1 inch (25.4 mm) beyond one vertical edge of board.**]
2. Furnish [**2-inch- (50-mm-)**] wide lead strips for backing joints.
3. Furnish finishing materials, accessories, and trim for lead-lined gypsum board complying with Section 092900 "Gypsum Board."

2.8 LEAD-LINED SOFTWOOD PLYWOOD

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**Accurate Radiation Shielding, Inc.**]

3. [**El Dorado Metals, Inc**]
4. [**General Veneer Manufacturing Co**]
5. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
6. [**Mayco Industries**]
7. [**NELCO Worldwide**]
8. [**New Shield, Inc.**]
9. [**Pitts Little Corporation**]
10. [**Radiation Protection Products, Inc**]
11. [**Ray-Bar Engineering Corp**]

B. Lead-Lined Softwood Plywood: DOC PS 1, Exposure 1; [**fire-retardant-treated**]with touch-sanded C-plugged veneer on face to receive lead lining. [**5/8-inch- (15.9-mm-)**][**3/4-inch- (19-mm-)**] thick plywood of width and length required for support spacing, with a single sheet of lead laminated to the back of the panel.

1. Lead Sheet Lining: Full width [**and length of panel**][**of panel and length necessary to extend from floor to 84 inches (2133 mm) above floor**][**of panel and height as indicated on Drawings**].[**Extend lead sheet lining 1 inch (25.4 mm) beyond one vertical edge of panel.**]
2. Furnish [**2-inch- (50-mm-)**] wide lead strips for backing joints.
3. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
4. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
5. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
6. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
7. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.9 LEAD GLASS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**ABM Lead Corporation**]
3. [**Accurate Radiation Shielding, Inc.**]
4. [**Amerope Enterprises, Inc**]
5. [**El Dorado Metals, Inc**]
6. [**Global Partners in Shielding, Inc.**]
7. [**Hot Cell Services Corporation**]
8. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
9. [**Mayco Industries**]
10. [**McGrory Glass, Inc**]
11. [**NELCO Worldwide**]
12. [**New Shield, Inc.**]
13. [**Pitts Little Corporation**]

14. [**Radiation Protection Products, Inc**]
15. [**Ray-Bar Engineering Corp**]
16. [**Schott North America, Inc.**]
17. [**Ultraray Radiation Protection**]

B. Lead Glass: Lead-barium, polished glass containing not less than 60 percent heavy metal oxides, including not less than 48 percent lead oxide by weight.

1. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
2. Tempered Safety Glass: ASTM C1048, Kind FT (fully tempered), lead glass with thickness [**as needed to provide lead equivalence indicated**][**as indicated**].
3. Laminated Safety Glass: ASTM C1172 lead glass with thickness [**as needed to provide lead equivalence indicated**][**as indicated**] laminated with polyvinyl butyral interlayer to clear float glass on [**one side**][**both sides**]of lead glass.

2.10 LEAD GLAZING PLASTIC

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
2. [**Mayco Industries**]
3. [**NELCO Worldwide**]
4. [**Ultraray Radiation Protection**]

B. Lead Glazing Plastic: Transparent acrylic sheet impregnated with an organolead compound and containing 30 percent lead by weight.

1. Thickness: [**As needed to provide lead equivalence indicated**][**As indicated**].

2.11 LEAD-LINED HOLLOW-METAL DOORS

A. Lead-Lined Hollow-Metal Doors: Steel doors complying with NAAMM-HMMA 861, except as indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A&L Shielding Inc.**]
b. [**Accurate Radiation Shielding, Inc.**]
c. [**DCI Hollow Metal on Demand**]
d. [**Deronde Products**]
e. [**El Dorado Metals, Inc**]
f. [**Global Partners in Shielding, Inc.**]
g. [**Karpen Steel Custom Doors & Frames**]
h. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
i. [**NELCO Worldwide**]
j. [**New Shield, Inc.**]
k. [**Pitts Little Corporation**]
l. [**Ray-Bar Engineering Corp**]

m. [**Republic Doors and Frames; a Allegion brand**]
n. [**Security Metal Products; a brand of ASSA ABLOY**]
o. [**Ultraray Radiation Protection**]

2. Provide single continuous sheet of lead of thickness [**not less than that required for partition in which door is installed**][**as indicated on Drawings**] extending from top to bottom and edge to edge, supported by hat-channel stiffeners. Do not weld stiffeners through lead lining.
3. Line-inverted channels at top and bottom of doors with lead sheet of same thickness used in door and close with filler channels to provide flush top and bottom edges.
4. Shield cutouts for locksets with lead sheet of same thickness used in door. Overlap lining of cutouts with lining of door by **1 inch (25 mm)**.
5. Prepare doors to receive [**glazed lights**][**and**][**louvers**]; Factory cut and trim openings through doors. Furnish removable stops for glazed openings.
6. Furnish lead-lined astragals for pairs of doors.
7. Factory fit doors to suit frame-opening sizes indicated with [**1/16-inch (1.6-mm)**] clearance at heads and jambs and minimum clearance at bottom.
8. Finish: Apply manufacturer's [**standard primer immediately after cleaning and pretreating**][**factory-applied paint**].

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; [factory primed for paint][with baked-enamel- or powder-coated] finish[and approved for use in doors of fire-protection rating indicated].

C. Lead Door Louvers: Louvers with [**20**][**30**] percent free area made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Fit and assemble louvers in doors at factory.

2.12 LEAD-LINED HOLLOW-METAL FRAMES

A. Hollow-Metal Frames: Steel frames complying with NAAMM-HMMA 861, except as indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A&L Shielding Inc.**]
b. [**ABM Lead Corporation**]
c. [**Accurate Radiation Shielding, Inc.**]
d. [**DCI Hollow Metal on Demand**]
e. [**Deronde Products**]
f. [**El Dorado Metals, Inc**]
g. [**Global Partners in Shielding, Inc.**]
h. [**Karpen Steel Custom Doors & Frames**]
i. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
j. [**NELCO Worldwide**]
k. [**New Shield, Inc.**]
l. [**Pioneer Industries; AADG, Inc.; ASSA ABLOY**]
m. [**Pitts Little Corporation**]
n. [**Radiation Protection Products, Inc**]

o. [**Ray-Bar Engineering Corp**]
p. [**Republic Doors and Frames; a Allegion brand**]
q. [**Security Metal Products; a brand of ASSA ABLOY**]
r. [**Ultraray Radiation Protection**]

2. Provide knocked down frames [**where indicated**][**and**][**where installed in existing partitions**].
3. Provide borrowed lite observation window frames of split or telescoping design with welded corners, allowing frame to be installed after construction of partition.

   a. Construct so lead lining overlaps glazing material perimeter by at least **3/8 inch (9.5 mm)**, and furnish removable stops.
   b. Form sill with an opening for sound transmission. Offset sound passage to make opening lightproof and to maintain required lead equivalence at all points and in all directions.

4. Provide [**door**][**and**][**observation window**] frames from steel sheet with minimum thickness of **0.0667 inch (1.7 mm)**.
5. Furnish with additional reinforcements and internal supports to adequately carry the weight of lead-lined doors. Install reinforcements and supports before installing lead lining.
6. Line frame with lead sheet of thickness not less than that required for doors and walls where frames are used. Form lead sheet to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective lap with lead of adjacent shielding.
7. Finish: Apply manufacturer's [**standard primer immediately after cleaning and pretreating**][**factory-applied paint**].

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.13 LEAD-LINED FLUSH WOOD DOORS

A. Lead-Lined Flush Wood Doors: Solid-core wood doors with lead sheet laminated to each side of core, with faces applied over lead lining.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A&L Shielding Inc.**]
   b. [**Accurate Radiation Shielding, Inc.**]
   c. [**General Veneer Manufacturing Co**]
   d. [**Lambton Doors**]
   e. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
   f. [**Masonite Architectural**]
   g. [**Oshkosh Door Company**]
   h. [**Poncraft Door Company**]
   i. [**Radiation Protection Products, Inc**]
   j. [**Ray-Bar Engineering Corp**]
   k. [**Ultraray Radiation Protection**]
   l. [**Vancouver Door Company**]
   m. [**VT Industries, Inc.**]

2. Construction: Hot pressed, bonded (vertical and horizontal edging is bonded to core), with entire

unit abrasive planed before applying lead lining and faces.

3. Core: [**Mineral**][**Particleboard**][**Structural composite lumber**].
4. Lead Lining: Continuous sheets of lead extending from top to bottom and edge to edge; with total lead thickness [**not less than that required for partition in which door is installed**][**as indicated on Drawings**].
5. Wood Veneer Faces: Wood veneer applied to crossbands over core.

    a. Comply with Section 081416 "Flush Wood Doors" for veneer species, grade, and matching; finishing; and other requirements unless otherwise indicated.

6. Plastic-Laminate Faces: High-pressure decorative laminate complying with ISO 4586-3, [**Grade HGS**][**Grade HDS**]; applied to crossbands over core.
7. ANSI/WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

B. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

C. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

D. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

E. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

F. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
    d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

5. Composite Wood Products: Products shall be made without urea formaldehyde.
6. Adhesives: Do not use adhesives that contain urea formaldehyde.
7. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Adhesives: Use adhesives that meet the testing and product requirements of the California

Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

9. Adhesives: Do not use adhesives that contain urea formaldehyde.
10. Adhesives: Do not use adhesives that contain urea formaldehyde.

G. Lead Door Louvers: Louvers with [**20**][**30**] percent free area, made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Factory fit and assemble louvers in doors.

H. Prepare doors to receive [**glazed lights**][**and**][**louvers**]; factory cut and trim openings through doors.[**Provide removable wood stops for glazed lights.**]

I. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; [factory primed for paint][with baked-enamel- or powder-coated] finish[and approved for use in doors of fire-protection rating indicated].

J. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.

K. Furnish lead-lined astragals for pairs of doors.

L. Factory fit doors to suit frame openings indicated with [**1/16-inch (1.6-mm)**] clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.

2.14 LEAD-LINED SPLIT-CORE WOOD DOORS

A. Lead-Lined Split-Core Wood Doors: Solid-core wood doors with lead lining in center of core; with lead thickness [**not less than that required for partition in which door is installed**][**as indicated on Drawings**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A&L Shielding Inc.**]
    b. [**ABM Lead Corporation**]
    c. [**Accurate Radiation Shielding, Inc.**]
    d. [**Ampco by AJW**]
    e. [**El Dorado Metals, Inc**]
    f. [**Global Partners in Shielding, Inc.**]
    g. [**NELCO Worldwide**]
    h. [**New Shield, Inc.**]
    i. [**Pitts Little Corporation**]
    j. [**Radiation Protection Products, Inc**]
    k. [**Ray-Bar Engineering Corp**]

2. Construction: Split core with lead lining in center of core; bonded (vertical and horizontal edging is bonded to core). Assemble lead lining and core with poured-lead fasteners or steel bolts. Space fasteners not more than **1-1/2 inches (38 mm)** from door edge and about **8 inches (200 mm)** o.c. Countersink bolt heads and cover with lead.
3. Core: [**Mineral**][**Particleboard**][**Structural composite lumber**].
4. Lead Lining: Provide continuous sheet of lead extending from top to bottom and edge to edge;

with total lead thickness [**not less than that required for partition in which door is installed**][**as indicated on Drawings**].

5. Wood Veneer Faces: Wood veneer applied to crossbands over core.

    a. Comply with Section 081416 "Flush Wood Doors" for veneer species, grade, and matching; finishing; and other requirements unless otherwise indicated.

6. Plastic-Laminate Faces: High-pressure decorative laminate complying with ISO 4586-3, [**Grade HGS**][**Grade HDS**]; applied to crossbands over core.
7. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
8. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
9. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
10. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
11. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
12. Composite Wood Products: Products shall be made without urea formaldehyde.
13. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
14. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
15. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
    d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

16. Composite Wood Products: Products shall be made without urea formaldehyde.
17. Adhesives: Do not use adhesives that contain urea formaldehyde.
18. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
19. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
20. Adhesives: Do not use adhesives that contain urea formaldehyde.
21. Adhesives: Do not use adhesives that contain urea formaldehyde.

B. Lead Door Louvers: Louvers with [**20**][**30**] percent free area, made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Factory fit and assemble louvers in doors.

C. Prepare doors to receive [**glazed lights**][**and**][**louvers**]; factory cut and trim openings through doors.[**Provide removable wood stops for glazed lights.**]

D. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; [factory primed for paint][with baked-enamel- or powder-coated] finish[and approved for use in doors of fire-protection rating indicated].

E. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.

F. Furnish lead-lined astragals for pairs of doors.

G. Factory fit doors to suit frame openings indicated with [**1/16-inch (1.6-mm)**] clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.

2.15 LEAD-LINED MODULAR SHIELDING PARTITIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Accurate Radiation Shielding, Inc.**]
2. [**Amerope Enterprises, Inc**]
3. [**Global Partners in Shielding, Inc.**]
4. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
5. [**New Shield, Inc.**]
6. [**Radiation Protection Products, Inc**]
7. [**Ray-Bar Engineering Corp**]
8. [**S&S Technology**]
9. [**Ultraray Radiation Protection**]

B. Lead-Lined Modular Shielding Partitions: Partial-height modular partitions assembled from factory-finished standard components consisting of lead-lined, steel or aluminum framing members; lead-lined opaque panels; lead glass or glazing plastic vision panels; and hardware necessary for assembly and for securing to other construction. Fabricate opaque panels from honeycomb-core metal panels with polyurethane paint finish.

1. Lead Equivalence for Opaque Panels: [**1/16 inch (1.6 mm)**].
2. Lead Equivalence for Framing Members: [**1/16 inch (1.6 mm)**].
3. Lead Equivalence for Vision Panels: [**1/16 inch (1.6 mm)**].
4. Color of Panels and Framing: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.16 INFORMATIONAL SIGNS

A. Panel Signs: Comply with Section 101423 "Panel Signage."

1. Color: As selected by Architect from manufacturer's full range of colors, as directed by the Owner.
2. Provide copy indicated or as directed.
3. Indicate lead equivalence in millimeters and heights of radiation protection in **inches (millimeters)**.

B. High-Pressure-Laminate Signs: High-pressure laminate engraving stock with contrasting face and core, machine engraved from master templates for accurately formed letters, numbers, and symbols.

1. Color: As selected by Architect from manufacturer's full range of colors, as directed by the Owner.
2. Provide copy indicated or as directed.
3. Indicate lead equivalence in millimeters and heights of radiation protection in **inches (millimeters)**.

C. Rooms Where the Level of Protection Is Uniform Throughout: Provide one sign for each room indicating lead equivalence of partitions, ceilings, floors, doors, and other portions of radiation protection enclosure. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height.

D. Rooms Where the Level of Protection Is Not Uniform Throughout: Provide one sign for each room with different lead equivalences in different locations. Indicate, in tabular form, lead equivalence of each wall, partition, ceiling, floor, door, and window. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height. Indicate where lead equivalence changes or is not continuous.

E. Rooms Where Some Partitions Are without Radiation Protection: Provide one sign for each partition that contains radiation protection, and indicate its lead equivalence. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height.

F. Rooms Where Only the Door Has Radiation Protection: Provide one sign for each door indicating its lead equivalence.

G. Mounting: Provide manufacturer's standard [two-faced tape][adhesive].

2.17 DOOR AND DOOR FRAME FABRICATION

A. Hardware Preparation: Factory prepare doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with door hardware schedule and templates furnished, as specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

2.18 MISCELLANEOUS MATERIALS

A. Glazing Compounds, Gaskets, and Accessories: Comply with requirements in Section 088000 "Glazing."

B. Accessories and Fasteners: Manufacturer's standard fasteners and accessories as required for installation, maintaining same lead equivalence as rest of system.

C. Asphalt Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

D. Asphalt Felt: ASTM D226/D226M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates with Installer present for compliance with requirements, installation tolerances, and other conditions affecting performance of radiation protection.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LEAD SHEET, STRIP, AND PLATES

A. Proceed with installation only after concrete surfaces are clean, dry, and free of depressions and sharp projections that could damage or penetrate lead sheet.

B. Coat concrete surfaces with asphalt emulsion before installing lead sheet.

C. Lead Sheet, 1/8 Inch (3.18 mm) Thick or Less: Install in a single layer with a **2-inch (50-mm)** minimum lap at joints.

D. Lead Sheet More Than 1/8 Inch (3.18 mm) Thick: Install in two or more layers with a **2-inch (50-mm)** minimum lap at joints, or in a single layer with joints butted and covered with a **4-inch- (100-mm-)** wide lead strip of same thickness.

E. Extend lead sheet at least **12 inches (300 mm)** beyond radiation shielding in walls of treatment room.

F. In floor slabs above shielded rooms, where lead sheet is indicated, extend lead sheet at least **12 inches (300 mm)** beyond radiation shielding in walls of room below.

G. At door openings, extend lead sheet at least 12 inches (300 mm) beyond radiation protection in walls and at least 12 inches (300 mm) beyond door opening on both sides[except where lead-lined thresholds are provided].

H. After installation, apply [**one coat**][**two coats**] of asphalt emulsion on top surface of lead sheet and protect from damage until concrete topping is placed.

3.3 INSTALLATION OF LEAD BRICKS

A. Remove projections from concrete surfaces to receive lead bricks, and apply one layer of asphalt felt to prevent contact between lead bricks and concrete.

1. At recesses in concrete floors to receive lead bricks, turn up asphalt felt at perimeter of recess.

B. Install lead bricks to dimensions indicated, tightly fitted together, with joints offset in succeeding courses. Cut bricks neatly at joints with adjacent materials for a snug fit, with edges straight and true and at right angles.

C. Secure lead bricks to structure, as indicated on approved Shop Drawings.

3.4 INSTALLATION OF HIGH-DENSITY CONCRETE BLOCKS

A. Dry-stack blocks in running bond, using methods recommended in writing by high-density concrete block manufacturer.

B. Install concrete blocks to dimensions indicated, tightly fitted together, with joints offset in succeeding courses. Cut neatly at joints with adjacent materials for a snug fit, with edges straight and true and at right angles.

C. Secure concrete blocks to structure, as indicated on approved Shop Drawings.

3.5 INSTALLATION OF LEAD-LINED GYPSUM BOARD

A. Install and finish lead-lined gypsum board in accordance with Section 092900 "Gypsum Board."

B. Install lead-lined gypsum board panels with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints.[**Install using construction adhesive and supplementary fasteners.**]

C. Install lead-lined gypsum board panels in sequence, so lead lining that extends beyond edge of gypsum board is covered by next panel installed.

D. At joints where lead lining does not extend beyond edge of gypsum board panels, install lead strips **2 inches (50 mm)** wide and same thickness as lead lining to face of framing and blocking. Secure lead strips with construction adhesive.

E. Provide shims at face of supports and blocking, where lead lining does not overlap, to provide a uniform plane across panel surfaces.

F. Fasten lead-lined gypsum board to framing, with steel drill screws spaced as recommended in writing by lead-lined gypsum board manufacturer.

G. Two-Layer System: Apply a facing sheet of gypsum board vertically over base sheet, using laminating adhesive recommended in writing by gypsum board manufacturer. Offset joints in finish layer from joints in base layer, and fasten at top and bottom of sheet to support finish panel until adhesive has set.

H. Openings: Extend lead-lined gypsum board into frames of openings, lapping lead lining with lead frames or frame linings at least **1 inch (25 mm)**. Arrange board around openings, so neither horizontal nor vertical joints occur at corners of openings.

I. Install control and expansion joints where indicated, with appropriate trim accessories. Install lead strip on face of framing, extending across joint, and lap with lead lining of gypsum board.

3.6 INSTALLATION OF LEAD-LINED SOFTWOOD PLYWOOD

A. Install fastener shields to framing before installing lead strips at joints.

B. Install lead strips **2 inches (50 mm)** wide and same thickness as lead lining to face of framing and blocking. Secure lead strips with construction adhesive.

C. Provide shims at face of supports and blocking, where lead lining does not overlap, to provide a uniform, plane across panel surfaces.

D. Install lead-lined plywood panels with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints. Fasten lead-lined plywood panels to framing, with adhesive and steel drill screws spaced as recommended in writing by panel manufacturer.

3.7 INSTALLATION OF LEAD-LINED DOORS AND DOOR FRAMES

A. Install lead-lined steel [**doors**][**and**][**door frames**] in accordance with Section 081113 "Hollow Metal Doors and Frames."

1. Apply a coat of asphalt mastic or paint to lead lining in door frames where lead comes in contact with masonry or concrete.

B. Install lead-lined wood doors in accordance with Section 081416 "Flush Wood Doors."

C. Lead-Lined Hollow-Metal Door Frames: Comply with ANSI/NAAMM-HMMA 840 unless otherwise indicated. Except for frames located in existing walls or partitions, place frames before constructing walls. Set frames accurately in position, plumb, and brace securely until permanent anchors are set.

1. Provide three anchors per jamb, located adjacent to hinge on hinge jamb and at corresponding heights on strike jamb.
2. In masonry construction, use wire or T-strap anchors, and apply a coat of asphalt mastic or paint to lead lining where lead comes in contact with masonry or grout.
3. In metal stud construction, use wall anchors attached to studs with screws.
4. In wood stud construction, use strap anchors attached to studs with screws.

D. Lead-Lined Split-Frame Observation Windows: Install lead-lined hollow-metal frames with split or telescoping design, with leaded side of frame on radiation side of wall.

E. Lap lead lining of frames over lining in walls at least **1 inch (25 mm)**.

F. Lead Lining of Frames: Line inside of frames with lead of thickness of not less than that required in doors and walls where frames are used. Form lead to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Lap lining over lining in walls at least **1 inch (25 mm)**.

G. Install leaded side of frame on radiation side of wall. Lap lead lining of frames over lining in walls at least **1 inch (25 mm)**.

H. Lead Glazing: Comply with installation requirements in Section 088000 "Glazing" and with manufacturer's written instructions.

I. Line astragals with lead sheet.

J. Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors. See Section 087100 "Door Hardware" for other installation requirements.

3.8 INSTALLATION OF LEAD-LINED MODULAR SHIELDING PARTITIONS

A. Install partitions after finishes are complete in spaces where partitions are located. Install in accordance with manufacturer's written instructions and approved Shop Drawings.

B. Cut and remove wall base where modular shielding partitions meet other walls, so partition fits tightly to wall.

C. Secure partition framing to floor with **1/4-inch (6.35-mm)** expansion anchors **16 inches (400 mm)** o.c., and fasten to walls and ceilings as indicated. Brace partitions with tie rods fastened to walls or ceilings as indicated.

3.9 INSTALLATION OF PENETRATING ITEMS

A. At penetrations of lead linings, provide lead shields to maintain continuity of protection.

B. Provide lead linings, sleeves, shields, and other protection in thickness of not less than that required in assembly being penetrated.

C. Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners unless indicated on Drawings.

D. Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least **1 inch (25 mm)**. Wrap conduit with lead sheet for a distance of not less than **10 inches (250 mm)** from box.

E. Duct Openings: Unless otherwise indicated, line or wrap ducts with lead sheet for distance from partition/ceiling equal to 3 times the largest opening dimension. Lap lead sheet with adjacent lead lining at least **1 inch (25 mm)**.

F. Piping: Unless otherwise indicated, wrap piping with lead sheet for a distance of not less than **10 inches (250 mm)** from point of penetration.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: the Owner will engage a qualified testing agency to perform tests and inspections after radiology equipment has been installed and placed in operating condition.

B. Correct deficiencies in or remove and replace radiation protection that inspection reports indicate does not comply with specified requirements.

3.11 PROTECTION

A. Lock radiation-protected rooms once doors and locks are installed, and limit access to only those persons performing work in the rooms.

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Task	Specification	Specification Description
13 49 13 00	13 49 00 00	Radiation Protection
13 49 16 00	13 49 00 00	Radiation Protection
13 49 19 00	13 49 00 00	Radiation Protection
13 49 19 16	13 49 00 00	Radiation Protection

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SECTION 22 01 40 81 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency showers.
2. Emergency eyewashes.
3. Emergency eye/face washes.
4. Emergency combination showers with eyewashes.
5. Emergency combination showers with eye/face washes.
6. Emergency recessed safety stations.
7. Supplemental equipment.
8. Water-tempering equipment.

1.2 DEFINITIONS

A. Barrier-Free Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.

D. Tepid: Between **60 and 100 deg F (16 and 38 deg C)**.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings:

1. Plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushing-Fluid Solution: Separate lot and equal to at least [**200**]<**Insert number**> percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Plumbing fixtures intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Comply with requirements in ICC A117.1 for installation of barrier-free emergency fixtures.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 EMERGENCY SHOWERS

A. Emergency Shower - Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Stingray Systems LLC**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]

c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Stingray Systems LLC**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency showers, freestanding, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
6. Supply Connection Size: [**NPS 1-1/4 (DN 32)**]<**Insert size**>.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Stainless steel**]<**Insert material**>.
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: Pull rod[**, 60-inch (1524-mm)**].

9. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum-diameter, [**stainless steel**][**plastic**]<**Insert material**>.
10. Mounting: Pedestal[**, barrier-free**].
11. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

B. Emergency Shower - Off Floor, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Sellstrom Manufacturing Company**]
g. [**Speakman Company**]
h. [**Stingray Systems LLC**]
i. [**WaterSaver Faucet Co**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Sellstrom Manufacturing Company**]
g. [**Speakman Company**]
h. [**Stingray Systems LLC**]
i. [**WaterSaver Faucet Co**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency showers, off floor, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1 (DN 25)**.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Chrome-plated brass**][**Stainless steel**].
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: Pull rod[**, 60-inch (1524-mm)**].

9. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum-diameter, [**stainless steel**][**plastic**]<**Insert material**>.
10. Mounting: [**Horizontal from wall**][**Vertical from ceiling**][**, barrier-free**] and supported from structure.
11. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

C. Emergency Shower - Wall Mounted, Fully Recessed, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Guardian Equipment Co**]
    d. [**Haws Corporation**]
    e. [**Speakman Company**]
    f. [**WaterSaver Faucet Co**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency showers, wall mounted, fully recessed, plumbed, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1 (DN 25)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**]<**Insert material**>.
8. Control Valve: Stay-open type with flow regulator.
9. Enclosure: Wall-mounted, fully recessed, stainless steel enclosure with vandal-resistant access panel.
10. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum-diameter, stainless steel <**Insert material**>.
11. Mounting: [**Horizontal from wall**][**Vertical from ceiling**][**, barrier-free**] and supported from structure.
12. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

D. Emergency Shower - Freeze Resistant, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Guardian Equipment Co**]
    c. [**Haws Corporation**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Guardian Equipment Co**]
c. [**Haws Corporation**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency showers, freeze resistant, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1 (DN 25)**.
7. Integral Supply Pipe Material: Galvanized steel.
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: Wall-mounted push handle.

9. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum-diameter, [**stainless steel**][**plastic**]<**Insert material**>.
10. Mounting: Horizontal from wall[**, barrier-free**]. Concealed piping within heated space.
11. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

2.3 EMERGENCY EYEWASHES

A. Emergency Eyewash - Standard, Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Guardian Equipment Co**]
c. [**Speakman Company**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Guardian Equipment Co**]
c. [**Speakman Company**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, standard, freestanding, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Stainless steel**]<**Insert material**>.
8. Control Valve:

a. Type: Stay-open type valve with flow regulator.
b. Actuator: [**Paddle**][**Treadle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**] bowl.
11. Drain Piping:

a. Size: **NPS 1-1/4 (DN 32)** minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Pedestal.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

B. Emergency Eyewash - Barrier-Free, Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Stingray Systems LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Stingray Systems LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, barrier free, freestanding, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Stainless steel**]<**Insert material**>.
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**] bowl.
11. Drain Piping:

a. Size: **NPS 1-1/4 (DN 32)** minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Offset pedestal.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

C. Emergency Eyewash - Standard, Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Speakman Company**]
c. [**Stingray Systems LLC**]
d. [**WaterSaver Faucet Co**]

e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bradley Corporation**]
   b. [**Speakman Company**]
   c. [**Stingray Systems LLC**]
   d. [**WaterSaver Faucet Co**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, standard, wall mounted, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**]<**Insert material**>.
8. Control Valve:

   a. Type: Stay-open with flow regulator.
   b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**]<**Insert material**> bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Wall bracket.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

D. Emergency Eyewash - Barrier Free, Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Speakman Company**]
c. [**Stingray Systems LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Speakman Company**]
c. [**Stingray Systems LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, barrier free, wall mounted, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**]<**Insert material**>.
8. Control Valve:

a. Type: Stay-open with flow regulator.
b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**]<**Insert material**> bowl.
11. Drain Piping:

a. Size: **NPS 1-1/4 (DN 32)** minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Wall bracket.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

E. Emergency Eyewash - Deck or Wall Mounted, Swivel Type, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Bradley Corporation**]
b. [**Guardian Equipment Co**]
c. [**Speakman Company**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Guardian Equipment Co**]
c. [**Speakman Company**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, [**deck**][**wall**] mounted, swivel type, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**].
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: [**Rotation of spray-head assembly**][**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two spray heads with offset piping.
10. Mounting: [**Deck mounted next to sink**][**Deck mounted on sink**][**Wall mounted**]<**Insert mounting**>.

F. Emergency Eyewash - Portable, Self-Contained :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Encon Safety Products**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Encon Safety Products**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, portable, self-contained, from single manufacturer.
4. Standard: ANSI/ISEA Z358.1.
5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Pressure Tank: [**10 gal. (38 L)**]<**Insert value**>, stainless steel, cylindrical, with pressure gauge, and suitable for on-floor installation.
7. Flushing Fluid: Medically acceptable solution manufactured and labeled in accordance with applicable regulations.
8. Spray-Head Assembly: [**Chrome-plated copper alloy**][**Stainless steel**] piping with flow regulator; control valve; and two spray heads mounted on tank.
9. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: Paddle.

10. Drench Hose: Handheld spray head with squeeze-handle actuation and hose attached to tank.

G. Emergency Eyewashes - Standard, Self-Contained :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Honeywell Industrial Safety; Honeywell International, Inc.**]
g. [**Sellstrom Manufacturing Company**]
h. [**Speakman Company**]
i. [**WaterSaver Faucet Co**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]

f. [**Honeywell Industrial Safety; Honeywell International, Inc.**]
g. [**Sellstrom Manufacturing Company**]
h. [**Speakman Company**]
i. [**WaterSaver Faucet Co**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, standard, self-contained, from single manufacturer.
4. Standard: ANSI/ISEA Z358.1.
5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Gravity Tank: [**7 gal. (27 L) minimum**]<**Insert value**>, plastic, and suitable for shelf mounting.
7. Flushing Fluid: Medically acceptable solution manufactured and labeled in accordance with applicable regulations.
8. Actuator: Pull-down front panel or pull strap.
9. Spray Heads: Protected, two mounted on tank.

H. Emergency Eyewash - Freeze Resistant, Self-Contained :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Encon Safety Products**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Encon Safety Products**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, freeze resistant, self-contained, from single manufacturer.
4. Standard: ANSI/ISEA Z358.1.
5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Gravity Tank: [**7 gal. (27 L) minimum**][**14 gal. (53 L) minimum**][**20 gal. (76 L) minimum**]<**Insert value**>, plastic, and suitable for shelf mounting.
7. Flushing Fluid: Medically acceptable solution manufactured and labeled in accordance with applicable regulations.
8. Actuator: Pull-down front panel or pull strap.
9. Spray Heads: Protected, two mounted on tank.
10. Heating System: Electric, 120 V ac; insulation enclosed in a protective jacket.

2.4 EMERGENCY EYE/FACE WASHES

A. Emergency Eye/Face Wash - Standard, Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Encon Safety Products**]
    d. [**Guardian Equipment Co**]
    e. [**Haws Corporation**]
    f. [**Speakman Company**]
    g. [**Stingray Systems LLC**]
    h. [**WaterSaver Faucet Co**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Encon Safety Products**]
    d. [**Guardian Equipment Co**]
    e. [**Haws Corporation**]
    f. [**Speakman Company**]
    g. [**Stingray Systems LLC**]
    h. [**WaterSaver Faucet Co**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, standard, freestanding, plumbed, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Stainless steel**][**PVC**].
8. Control Valve:

    a. Type: Stay-open type with flow regulator.
    b. Actuator: [**Paddle**][**Treadle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**] bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.

c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Pedestal.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

B. Emergency Eye/Face Wash - Barrier Free, Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, barrier free, freestanding, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Stainless steel**].
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**] bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.

12. Mounting: Offset pedestal.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

C. Emergency Eye/Face Wash - Standard, Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Encon Safety Products**]
    d. [**Guardian Equipment Co**]
    e. [**Haws Corporation**]
    f. [**Speakman Company**]
    g. [**Stingray Systems LLC**]
    h. [**WaterSaver Faucet Co**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Encon Safety Products**]
    d. [**Guardian Equipment Co**]
    e. [**Haws Corporation**]
    f. [**Speakman Company**]
    g. [**Stingray Systems LLC**]
    h. [**WaterSaver Faucet Co**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, standard, wall mounted, plumbed, from single manufacturer.

4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**][**PVC**]<**Insert material**>.
8. Control Valve:

    a. Type: Stay-open type with flow regulator.
    b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**]<**Insert material**> bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Wall bracket.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

D. Emergency Eye/Face Wash - Barrier Free, Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Guardian Equipment Co**]
    d. [**Haws Corporation**]
    e. [**Speakman Company**]
    f. [**Stingray Systems LLC**]
    g. [**WaterSaver Faucet Co**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]

b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, accessible, wall mounted, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**].
8. Control Valve:

a. Type: Stay-open with flow regulator.
b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**]<**Insert material**> bowl.
11. Drain Piping:

a. Size: **NPS 1-1/4 (DN 32)** minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Wall bracket.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

E. Emergency Eye/Face Wash - Deck or Wall Mounted, Swivel Type, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]

d. [**Haws Corporation**]
e. [**Stingray Systems LLC**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Stingray Systems LLC**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, [**deck**][**wall**] mounted, swivel type, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **3 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**].
8. Control Valve:

a. Type: Stay-open with flow regulator.
b. Actuator: Movement of spray-head assembly.

9. Spray-Head Assembly: Two or four spray heads with offset piping.
10. Mounting: [**Deck mounted**][**Wall mounted**]<**Insert mounting**>.

a. Location: [**Deck mounted next to sink**][**Deck mounted on sink**][**Wall mounted behind sink**]<**Insert mounting**>

F. Emergency Eye/Face Wash - Deck Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Guardian Equipment Co**]
c. [**WaterSaver Faucet Co**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Guardian Equipment Co**]

c. [**WaterSaver Faucet Co**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, deck mounted, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: Chrome-plated brass.
8. Control Valve:

a. Type: Stay-open type valve with flow regulator.
b. Actuator: [**Paddle**][**Push down**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four spray heads.
10. Receptor: Stainless steel <**Insert material**> bowl.
11. Drain Piping:

a. Size: **NPS 1-1/4 (DN 32)** minimum.
b. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Deck.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

2.5 EMERGENCY COMBINATION SHOWERS WITH EYEWASHES

A. Emergency Combination Shower with Eyewash, Standard, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Speakman Company**]

g. [**Stingray Systems LLC**]
h. [**WaterSaver Faucet Co**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Speakman Company**]
g. [**Stingray Systems LLC**]
h. [**WaterSaver Faucet Co**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with eyewashes, standard, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Integral Supply/Drain Pipe:

a. Material: [**Galvanized steel**][**Chrome-plated brass**][**Stainless steel**][**PVC**].
b. Supply Connection Size: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].
c. Drain Connection Size: Outlet at back or side near bottom. **NPS 1-1/4 (DN 32)** minimum.

6. Shower:

a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
b. Supply Piping: **NPS 1 (DN 25)**.
c. Control Valve:

1) Stay-open type with flow regulator.
2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**][**Treadle**]<**Insert actuator**>.

d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless steel**][**plastic**].
e. Mounting: Pedestal.

7. Eyewash:

a. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
b. Supply Piping Size: **NPS 1/2 (DN 15)**.
c. Control Valve:

1) Stay-open with flow regulator.
2) Actuator: Paddle.

d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: [**Stainless steel**][**Plastic**] bowl.

f. Mounting: Attached to shower pedestal.
g. Drench-Hose Option: May be provided instead of eyewash unit.

1) Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

8. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

B. Emergency Combination Shower with Eyewash, Barrier Free, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with eyewashes, barrier free, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Integral Supply/Drain Pipe:

   a. Material: [**Galvanized steel**][**Stainless steel**].
   b. Supply Connection Size: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].
   c. Drain Connection Size: Outlet at back or side near bottom. **NPS 1-1/4 (DN 32)** minimum.

6. Shower:

   a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
   b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
   c. Control Valve:

      1) Type: Stay-open type with flow regulator.
      2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**]<**Insert actuator**>.

   d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless steel**][**plastic**].
   e. Mounting: Pedestal.

7. Eyewash:

   a. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
   b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
   c. Control Valve:

      1) Type: Stay-open type with flow regulator.
      2) Actuator: Paddle.

   d. Spray-Head Assembly: Two receptor-mounted spray heads.
   e. Receptor: [**Stainless steel**][**Plastic**] bowl.
   f. Mounting: Attached shower pedestal.
   g. Drench-Hose Option: May be provided instead of eyewash unit.

      1) Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
      2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
      3) Mounting: Bracket on shower pedestal.

8. Accessories:

   a. Electric alarm with flashing light and horn.
   b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
   c. Flow switch; single pole.
   d. Modesty curtain.
   e. Magnetically actuated proximity switch.
   f. <**Insert size**> stainless steel ball valve.
   g. <**Insert accessory**>.

2.6 EMERGENCY COMBINATION SHOWERS WITH EYE/FACE WASHES

A. Emergency Combination Shower with Eye/Face Wash, Standard, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Speakman Company**]
g. [**Stingray Systems LLC**]
h. [**WaterSaver Faucet Co**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Speakman Company**]
g. [**Stingray Systems LLC**]
h. [**WaterSaver Faucet Co**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with eye/face washes, standard, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Integral Supply/Drain Pipe:

a. Material: [**Galvanized steel**][**Chrome-plated brass**][**Stainless steel**][**PVC**].
b. Supply Connection Size: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].
c. Drain Connection Size: Outlet at back or side near bottom. **NPS 1-1/4 (DN 32)** minimum.

6. Shower:

a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
c. Control Valve:

1) Type: Stay-open with flow regulator.
2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**][**Treadle**]<**Insert actuator**>.

d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless steel**][**plastic**].
e. Mounting: Pedestal.

7. Eye/Face Wash:

a. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
c. Control Valve:

1) Type: Stay-open type with flow regulator.
2) Actuator: Paddle.

d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
e. Receptor: [**Stainless steel**][**Plastic**] bowl.
f. Mounting: Attached shower pedestal.
g. Drench-Hose Option: May be provided instead of eye/face wash unit.

1) Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

8. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

B. Emergency Combination Shower with Eye/Face Wash, Barrier Free, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with eye/face washes, barrier free, plumbed, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.

5. Integral Supply/Drain Pipe:

    a. Material: [**Galvanized steel**][**Stainless steel**].
    b. Supply Connection Size: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].
    c. Drain Connection Size: Outlet at back or side near bottom. **NPS 1-1/4 (DN 32)** minimum.

6. Shower:

    a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
    c. Control Valve:

        1) Type: Stay-open type with flow regulator.
        2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**]<**Insert actuator**>.

    d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless steel**][**plastic**].
    e. Mounting: Pedestal.

7. Eye/Face Wash:

    a. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
    c. Control Valve:

        1) Type: Stay-open type with flow regulator.
        2) Actuator: Paddle.

    d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
    e. Receptor: [**Stainless steel**][**Plastic**] bowl.
    f. Mounting: Attached to shower pedestal.
    g. Drench-Hose Option: May be provided instead of eye/face wash unit.

        1) Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
        2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
        3) Mounting: Bracket on shower pedestal.

8. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

C. Emergency Combination Shower with Eyewash or Eye/Face Wash, Freeze Resistant, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**B-L-S Industries, Inc**]
    c. [**Bradley Corporation**]
    d. [**Encon Safety Products**]
    e. [**Guardian Equipment Co**]
    f. [**Haws Corporation**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**B-L-S Industries, Inc**]
    c. [**Bradley Corporation**]
    d. [**Encon Safety Products**]
    e. [**Guardian Equipment Co**]
    f. [**Haws Corporation**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with [**eyewashes**][**eye/face washes**], freeze resistant, plumbed, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.

5. Integral Supply Pipe Material: Galvanized steel.

    a. Supply Connection: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].

6. Heating System: Electric, [**120**][**240**] V ac; insulation enclosed in a protective jacket with thermometer.

    a. Heating Capacity: [**10 deg F (6 deg C)**]<**Insert temperature**> minimum above ambient temperature.
    b. Design Ambient Temperature: <**Insert temperature**>.

7. Shower:

    a. Shower Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
    c. Control Valve:

        1) Type: Stay-open type with flow regulator.
        2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**]<**Insert actuator**>.

    d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless**

steel][**plastic**].
e. Mounting: Pedestal.

8. Eyewash:

a. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
c. Control Valve:

1) Type: Stay-open with flow regulator.
2) Actuator: [**Paddle**]<**Insert actuator**>.

9. Eye/Face Wash:

a. Capacity: Not less than **3 gpm (11.4 L/min.)** for at least 15 minutes.
b. Control Valve:

1) Type: Stay-open type with flow regulator.
2) Actuator: [**Paddle**]<**Insert actuator**>.

10. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

2.7 EMERGENCY RECESSED SAFETY STATIONS

A. Emergency Recessed Safety Station - Emergency Eye/Face Wash with Shower, Barrier Free, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Guardian Equipment Co**]
b. [**Haws Corporation**]
c. [**WaterSaver Faucet Co**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Guardian Equipment Co**]
b. [**Haws Corporation**]
c. [**WaterSaver Faucet Co**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency recessed safety stations, emergency eye/face wash with shower, barrier free, plumbed, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.
    d. Barrier-free installation.

5. Cabinet:

    a. Mounting: Wall-mounted, fully recessed, stainless steel enclosure with vandal-resistant access panel.
    b. Fire Rated: [**1-hour**][**2-hour**].

        1) UL-listed as "Through Penetration Firestop System No. W-L-7167."

    c. Contents:

        1) Supply valves, flow regulator(s), strainers.
        2) Eye/face wash with daylight or no drain.
        3) Pull-down handle for shower valve activation.
        4) Combination cover and internal drain pan. Pull handle on face of unit down from vertical to horizontal position to activate eye/face wash.
        5) Internal Drain Connection: Outlet at bottom. **NPS 2 (DN 50)** minimum.

6. Eye/Face Wash:

    a. Capacity: Not less than **3 gpm (11.4 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull handle on face of unit down from vertical to horizontal position.
    d. Spray-Head Assembly: Two or four receptor-mounted spray heads.

7. Shower:

    a. Shower Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull handle on face of unit from up to down position.
    d. Shower Head: **8-inch- (200-mm-)** minimum diameter, [**chrome-plated brass**][**stainless steel**][**plastic**].
    e. Mounting: [**Horizontal from wall, exposed**][**Vertical from ceiling, exposed**][**Vertical from ceiling, recessed**].

8. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

2.8 SUPPLEMENTAL EQUIPMENT

A. Personal Eyewash - Self-Contained :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bradley Corporation**]
   b. [**Encon Safety Products**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bradley Corporation**]
   b. [**Encon Safety Products**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain self-contained, personal eyewashes from single manufacturer.
4. Standard: ANSI/ISEA Z358.1.
5. Capacity: Not less than **0.4 gpm (1.5 L/min.)**.
6. Pressure Tank: [**5 gal. (19 L)**]<**Insert value**>, stainless steel, cylindrical, with pressure gauge and base suitable for on-floor installation.
7. Flushing Fluid: Medically acceptable solution manufactured and labeled in accordance with applicable regulations.
8. Spray-Head Assembly: Chrome-plated copper alloy or stainless steel piping with flow regulator; paddle-actuated, stay-open control valve; and two spray heads mounted on tank.

B. Drench Hose - Deck Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Speakman Company**]
   f. [**WaterSaver Faucet Co**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Speakman Company**]

f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain drench hoses, deck mounted, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Fitting: **NPS 1/2 (DN 15)** brass with flow regulator.
7. Drench Hose: Handheld spray head with [**squeeze-handle**][**push handle ball valve**] actuation and hose.
8. Mounting: In hole on deck.

C. Drench Hose - Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain drench hoses, wall mounted, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Fitting: **NPS 1/2 (DN 15)** brass with flow regulator.
7. Drench Hose: Handheld spray head with [**squeeze-handle**][**push handle ball valve**] actuation and hose.
8. Mounting: Wall bracket.

2.9 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment - Hot and Cold Water :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Armstrong International, Inc**]
    c. [**Bradley Corporation**]
    d. [**Guardian Equipment Co**]
    e. [**Haws Corporation**]
    f. [**Lawler Manufacturing Company, Inc**]
    g. [**Leonard Valve Company**]
    h. [**Speakman Company**]
    i. [**Stingray Systems LLC**]
    j. [**WaterSaver Faucet Co**]
    k. [**WATTS; A Watts Water Technologies Company**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Armstrong International, Inc**]
    c. [**Bradley Corporation**]
    d. [**Guardian Equipment Co**]
    e. [**Haws Corporation**]
    f. [**Lawler Manufacturing Company, Inc**]
    g. [**Leonard Valve Company**]
    h. [**Speakman Company**]
    i. [**Stingray Systems LLC**]
    j. [**WaterSaver Faucet Co**]
    k. [**WATTS; A Watts Water Technologies Company**]
    l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water-tempering equipment, hot and cold water, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.

5. Description: Factory-fabricated equipment with thermostatic mixing valve.

    a. Thermostatic Mixing Valve: Designed to provide [**85 deg F (29 deg C)**]<**Insert temperature**> tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus [**5 deg F (3 deg C)**]<**Insert temperature**> throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, **and corrosion-resistant** enclosure. ASSE 1071 compliant.
    b. Supply Connections: For hot and cold water.

c. Cabinet: [**Surface**][**Recess**] mounted.

B. Water-Tempering Equipment - Electric, Tankless :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
c. [**Encon Safety Products**]
d. [**Haws Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
c. [**Encon Safety Products**]
d. [**Haws Corporation**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water-tempering equipment, electric, tankless from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Description: Factory-fabricated equipment with electric heating.

a. Heating System: Electric, designed to provide [**85 deg F (29 deg C)**]<**Insert temperature**> tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus [**5 deg F (3 deg C)**]<**Insert temperature**> throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, heating coils, high-temperature-limit device, metal piping, and corrosion-resistant enclosure.

1) Electrical Characteristics: [**208 V ac, single phase**][**240 V ac, single phase**][**277 V ac, single phase**][**208 V ac, 3 phase**][**240 V ac, 3 phase**][**480 V ac, 3 phase**], 60 Hz.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water[**and waste**] piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURES

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of fixture. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

1. Exceptions:

a. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency fixture.
b. Omit shutoff valve on supply to emergency fixture if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to emergency fixture if piping and fixture connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

G. Install trap and waste piping on drain outlet of emergency fixture receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in [**Section 221316 "Sanitary Waste and Vent Piping."**][**Section 221316 "Sanitary Waste and Vent Piping" and Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities."**]

H. Install indirect waste piping on drain outlet of emergency fixture receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in [**Section 221316 "Sanitary Waste and Vent Piping."**][**Section 221316 "Sanitary Waste and Vent Piping" and Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities."**]

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

J. Fill self-contained fixtures with flushing fluid.

3.3 PIPING CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

C. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with

requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in [**Section 221316 "Sanitary Waste and Vent Piping."**][**Section 221316 "Sanitary Waste and Vent Piping" and Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities."**] Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to [**sanitary waste**][**chemical waste**][**storm drainage**] piping.

E. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert dimension**> high.

3.5 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Emergency plumbing fixtures[**and water-tempering equipment**] will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.8 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 01 40 81

SECTION 22 05 00 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Packless expansion joints.
3. Grooved-joint expansion joints, lead free.
4. Alignment guides and anchors.
5. Sleeves without waterstop.
6. Sleeves with waterstop.
7. Stack-sleeve fittings.
8. Sleeve-seal systems.
9. Grout.
10. Silicone sealants.
11. Escutcheons.
12. Thermometers, bimetallic actuated, lead free.
13. Thermometers, filled system, lead free.
14. Thermometers, liquid in glass, lead free.
15. Thermometers, light activated, lead free.
16. Thermowells, lead free.
17. Pressure gauges, dial type, lead free.
18. Gauge attachments, lead free.
19. Test plugs, lead free.
20. Test-plug kits, lead free.
21. Sight flow indicators, lead free.

B. Related Requirements:

1. Section 221119 "Domestic Water Piping Specialties" for water meters.
2. Section 221513 "General-Service Compressed-Air Piping" for compressed air gauges.
3. Section 331415 "Site Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.

a. Include construction details, material descriptions, and dimensions of individual

components, and finishes.
b. Include operating characteristics and furnished accessories.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of [**expansion joint,**][**and**][**gauge**] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.7 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water[**expansion fittings and loops**] for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft. (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**].
10. Code Letter Designation:

    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.

b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes [**324T**] and larger; rolled steel for motor frame sizes smaller than [**324T**].

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

a. Permanent-split capacitor.
b. Split phase.
c. Capacitor start, inductor run.
d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [120 V][240 V] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [Circuit board][digital speed controller/LED display].
4. Building Automation System Interface: Via [AC voltage signal][DC voltage signal][Digital Serial Interface (DSI)].

2.3 EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Packless Expansion Joints:

1. Rubber Union Connector Expansion Joints, Lead Free: [**RUEJLF-01**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flexicraft Industries**]
4) [**Flo Fab Inc**]
5) [**General Rubber Corporation**]
6) [**Kadant Unaflex, LLC**]
7) [**Mason Industries, Inc.**]
8) [**Metraflex Company (The)**]
9) [**Proco Products, Inc**]
10) [**Unisource Manufacturing, Inc.**]

b. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
c. Material: Twin reinforced EPDM rubber spheres[**with external restraining cables**].
d. Minimum Pressure Rating: [**150 psig at 170 deg F (1035 kPa at 77 deg C)**] unless otherwise indicated.
e. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
f. End Connections for Greater than NPS 2 (DN 50): Flanged.
g. End Fittings: Stainless steel.

2. Flexible-Hose Packless Expansion Joints, Lead Free: [**FHEJLF-01**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ASC Engineered Solutions**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Kadant Unaflex, LLC**]
7) [**Mason Industries, Inc.**]
8) [**Proco Products, Inc**]
9) [**Unisource Manufacturing, Inc.**]

b. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.
c. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

d. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
e. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with [**solder-joint**] end connections.

1) Bronze hoses and single-braid bronze sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **340 psig at 450 deg F (2340 kPa at 232 deg C)** ratings.
2) Bronze hoses and double-braid bronze sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **500 psig at 450 deg F (3450 kPa at 232 deg C)** ratings.

f. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with [**threaded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **300 psig at 70 deg F (2070 kPa at 21 deg C)** and **225 psig at 450 deg F (1550 kPa at 232 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **420 psig at 70 deg F (2890 kPa at 21 deg C)** and **315 psig at 450 deg F (2170 kPa at 232 deg C)** ratings.

g. Expansion Joints for Stainless Steel Piping NPS 2 (DN 50) and Smaller: Stainless steel fittings with threaded end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **325 psig at 600 deg F (2250 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **515 psig at 600 deg F (3550 kPa at 315 deg C)** ratings.

h. Expansion Joints for Stainless Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Stainless steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **200 psig at 70 deg F (1380 kPa at 21 deg C)** and **145 psig at 600 deg F (1000 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **275 psig at 70 deg F (1900 kPa at 21 deg C)** and **200 psig at 600 deg F (1380 kPa at 315 deg C)** ratings.

i. Expansion Joints for Stainless Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Stainless steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **125 psig at 70 deg F (860 kPa at 21 deg C)** and **90 psig at 600 deg F (625 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **165 psig at 70 deg F (1130 kPa at 21 deg C)** and **120 psig at 600 deg F (830 kPa at 315 deg C)** ratings.

j. Expansion Joints for Stainless Steel Piping NPS 14 (DN 350) and Larger: Stainless steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and double-braid, stainless steel sheaths with

165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

3. Metal-Bellows Packless Expansion Joints, Lead Free: [**MBEJLF-01**].

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Adsco Manufacturing LLC**]
      2) [**Badger Industries, Inc**]
      3) [**Flex-Hose Co., Inc**]
      4) [**Flex-Pression**]
      5) [**Flex-Weld; a division of Kelco**]
      6) [**Flexicraft Industries**]
      7) [**Flo Fab Inc**]
      8) [**Hyspan Precision Products, Inc**]
      9) [**Kadant Unaflex, LLC**]
      10) [**Mason Industries, Inc.**]
      11) [**Proco Products, Inc**]
      12) [**Senior Flexonics Pathway**]
      13) [**Tozen Corporation**]
      14) [**U.S. Bellows, Inc.**]
      15) [**Unisource Manufacturing, Inc.**]
      16) [**Universal Hose and Braid; a Hyspan Company**]

   b. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
   c. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
   d. Type: Circular, corrugated bellows[**with external tie rods**].
   e. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**200 psig (1379 kPa)**] unless otherwise indicated.
   f. Configuration: [**Single joint**][**Single joint with base**][**and**][**double joint with base**] class(es) unless otherwise indicated.
   g. Expansion Joints for Copper Tubing: [Single-][multi-]ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

      1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: [Solder joint][threaded].
      2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [Solder joint][threaded].
      3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.

   h. Expansion Joints for Stainless Steel Piping: [Single-][multi-]ply stainless steel bellows, stainless steel pipe ends, and carbon steel shroud.

      1) End Connections for Stainless Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
      2) End Connections for Stainless Steel Pipe NPS 2-1/2 (DN 65) and Larger: [**Flanged**][**Welded**].

4. Externally Pressurized Metal-Bellows Packless Expansion Joints, Lead Free: [**EPEJLF-01**].

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Adsco Manufacturing LLC**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Hyspan Precision Products, Inc**]
7) [**Mason Industries, Inc.**]
8) [**Metraflex Company (The)**]
9) [**Senior Flexonics Pathway**]
10) [**Tozen Corporation**]
11) [**U.S. Bellows, Inc.**]
12) [**Unisource Manufacturing, Inc.**]

b. Source Limitations: Obtain externally pressurized metal-bellows packless expansion joints from single manufacturer.
c. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1379 kPa)**][**300 psig (2068 kPa)**] unless otherwise indicated.
d. Description:

1) Totally enclosed, externally pressurized, multi-ply, stainless steel bellows isolated from fluid flow by an internal pipe sleeve.
2) Carbon-steel housing.
3) Drain plugs and lifting lug for **NPS 3 (DN 80)** and larger.
4) Bellows: With operating clearance between the internal pipe sleeves and external shrouds.
5) Joints: Supplied with a built-in scale to confirm the starting position and operating movement.
6) Joint Axial Movement: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**] of compression and [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**] of extension.

e. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are unacceptable.
f. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

5. Rubber Packless Expansion Joints, Lead Free: [**REJLF-01**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Weld; a division of Kelco**]
4) [**Flexicraft Industries**]
5) [**Garlock Sealing Technologies**]
6) [**General Rubber Corporation**]
7) [**Kadant Unaflex, LLC**]
8) [**Mason Industries, Inc.**]
9) [**Proco Products, Inc**]

10) [**Red Valve Company, Inc**]
11) [**Tozen Corporation**]
12) [**U.S. Bellows, Inc.**]
13) [**Unisource Manufacturing, Inc.**]

b. Source Limitations: Obtain rubber packless expansion joints from single manufacturer.
c. Standards: ASTM F1123 and FSA's "Expansion Joints - Piping Technical Handbook."
d. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
e. Arch Type: [Single][multiple] arches[with external control rods].
f. Spherical Type: [Single][multiple] spheres[with external control rods].
g. Minimum Pressure Rating for NPS 1-1/2 to NPS 12 (DN 40 to DN 300): [**225 psig (1551 kPa) at 170 deg F (77 deg C)**].

C. Grooved-Joint Expansion Joints, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASC Engineered Solutions**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Victaulic Company**]

2. Source Limitations: Obtain grooved-joint expansion joints from single manufacturer.
3. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
4. Standard: AWWA C606, for grooved joints.
5. Material: ASTM A53/A53M, Schedule 40 stainless steel pipe with grooved ends.
6. Couplings: [**Five**][**Seven**][**10**][**12**], ASTM A312/A312M ductile-iron flexible type for stainless steel pipe dimensions. Include ferrous housing sections, Grade E EPDM rubber gasket or Grade P fluoroelastomer blend gasket, and bolts and nuts.

D. Alignment Guides and Anchors:

1. Alignment Guides: [**AG-01**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Thermal Systems, Inc**]
2) [**ASC Engineered Solutions**]
3) [**Flex-Hose Co., Inc**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Hyspan Precision Products, Inc**]
7) [**Metraflex Company (The)**]

b. Source Limitations: Obtain alignment guides from single manufacturer.
c. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.

2. Anchor Materials:

a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, [**zinc-coated carbon**][**stainless**] steel.
2) Expansion Plug: [**Zinc-coated carbon**][**Stainless**] steel.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, [**zinc-coated carbon**][**stainless**] steel with continuous thread on stud unless otherwise indicated.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

2.4 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge (0.6 mm)** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT; a division of EnPRO Industries**]
d. [**Metraflex Company (The)**]

2. Description: Manufactured [**PVC/HDPE**][**steel**][**stainless steel**][**galvanized-steel**], sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Wade; a subsidiary of McWane Inc.**]
c. [**Zurn Industries, LLC**]

2. Description: Manufactured, [**Dura-coated or Duco-coated**][**galvanized**] cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**GPT; a division of EnPRO Industries**]
c. [**Metraflex Company (The)**]
d. [**Proco Products, Inc**]

2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

a. Hydrostatic Seal: **20 psig (137 kPa)** minimum.
b. Sealing Elements: [**EPDM-rubber**][**High-temperature-silicone**][**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
c. Pressure Plates: [**Carbon steel**][**Composite plastic**][**Stainless steel**][**Stainless steel, Type 316**].
d. Connecting Bolts and Nuts: [**Carbon steel, with zinc coating, ASTM B633**][**Stainless steel**][**Stainless steel, Type 316**] of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
2) [**ITW Polymers Sealants North America**]
3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
4) [**Sherwin-Williams Company (The)**]
5) [**Sika Corporation**]
6) [**The Dow Chemical Company**]
7) [**Tremco Incorporated**]

b. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, [**25**][**100/50**], pourable, [**plus 25 percent and minus 25 percent**][**plus 100 percent and minus 50 percent**] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Pecora Corporation**]
2) [**Sika Corporation**]
3) [**The Dow Chemical Company**]
4) [**Tremco Incorporated**]

b. Standard: ASTM C920, Type S, Grade P, [**Class 25**][**Class 100/50**], Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Smooth-On**]

4. Sealant shall have a VOC content of [**250**] g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended

exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.5 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]

B. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**][**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**][**and**][**exposed-rivet**] hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Cast brass with concealed hinge.

2.6 METERS AND GAUGES FOR PLUMBING PIPING

A. Thermometers, Bimetallic Actuated, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Blue Ribbon Corp.**]
c. [**Ernst Flow Industries**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**WATTS; A Watts Water Technologies Company**]
l. [**Weiss Instruments, Inc**]
m. [**Weksler Glass Thermometer Corp.**]

n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide lead-free bimetallic-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Liquid-filled**][**and**][**sealed**] type(s); stainless steel with [**3-inch (75-mm)**][**5-inch (125-mm)**] nominal diameter.
5. Dial: [**Nonreflective aluminum**] with permanent scale markings and scales in [**deg F (deg C)**][**deg F and deg C**].
6. Connector Type(s): Union joint, [**adjustable angle**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
7. Stem: **0.25 or 0.375 inch (6.4 or 9.5 mm)** in diameter; [**stainless steel**][**lead-free brass**].
8. Window: [Plain glass][Safety glass][acrylic plastic].
9. Ring: Stainless steel.
10. Element: Bimetal coil.
11. Pointer: Dark-colored metal.
12. Accuracy: Plus or minus [**1**][**1.5**] percent of span.

B. Thermometers, Filled System, Lead Free - Direct Mounted, Metal Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ashcroft Inc**]
   b. [**Miljoco Corporation**]
   c. [**Palmer Wahl Instrumentation Group**]
   d. [**REOTEMP Instrument Corporation**]
   e. [**Trerice, H. O. Co**]
   f. [**Weiss Instruments, Inc**]

2. Source Limitations: Provide filled-system, lead-free, direct-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, [**cast aluminum or drawn steel**]; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**] nominal diameter.
5. Element: Lead-free [**Bourdon tube**].
6. Movement: Mechanical,[**dampening type,**] with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Pointer: Dark-colored metal.
9. Window: [Glass][Safety glass][acrylic plastic].
10. Ring: [**Metal**][**Stainless steel**].
11. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free bulb in copper-plated steel, aluminum, or lead-free brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus [**1**] percent of span.

C. Thermometers, Filled System, Lead Free - Direct Mounted, Plastic Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**REOTEMP Instrument Corporation**]

2. Source Limitations: Provide filled-system, lead-free, direct-mounted, plastic-case, vapor-actuated thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, [**plastic**]; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**] nominal diameter.
5. Element: Lead-free [**Bourdon tube**].
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Pointer: Dark-colored metal.
9. Window: [Glass][Safety glass][acrylic plastic].
10. Ring: [Metal][plastic].
11. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free bulb in copper-plated steel or aluminum, or lead-free brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Stem Length: To match thermowell insertion length.
14. Accuracy: Plus or minus [**1**] percent of span.

D. Thermometers, Filled System, Lead Free - Remote Mounted, Metal Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Miljoco Corporation**]
   b. [**Palmer Wahl Instrumentation Group**]
   c. [**REOTEMP Instrument Corporation**]
   d. [**Trerice, H. O. Co**]
   e. [**Weiss Instruments, Inc**]
   f. [**WIKA Instrument Corporation**]

2. Source Limitations: Provide filled-system, lead-free, remote-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, [**cast aluminum or drawn steel**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter with [**back**][**front**] flange and holes for panel mounting.
5. Element: Lead-free [**Bourdon tube**].
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Pointer: Dark-colored metal.

9. Window: [Glass][Safety glass][acrylic plastic].
10. Ring: [**Metal**][**Stainless steel**].
11. Connector Type(s): Union joint, [**back**][**bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free, bulb in copper-plated steel, aluminum, or lead-free brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Stem Length: To match thermowell insertion length.
14. Accuracy: Plus or minus [**1**] percent of span.

E. Thermometers, Filled System, Lead Free - Remote Mounted, Plastic Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]
    b. [**REOTEMP Instrument Corporation**]

2. Source Limitations: Provide filled-system, lead-free, remote-mounted, plastic-case, vapor-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, [**plastic**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter with [**back**][**front**] flange and holes for panel mounting.
5. Element: Lead-free [**Bourdon tube**].
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Pointer: Dark-colored metal.
9. Window: [Glass][Safety glass][acrylic plastic].
10. Ring: [Metal][plastic].
11. Connector Type(s): Union joint, threaded, [**back**][**bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free bulb in copper-plated steel, aluminum, or lead-free brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

F. Thermometers, Liquid in Glass, Lead Free - Metal Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]

2. Source Limitations: Provide liquid-in-glass, lead-free, metal-case, compact-style thermometers by

single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Cast aluminum**]; **6-inch (150-mm)** nominal size.
5. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[**or red**] organic liquid; mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Window: Glass or plastic.
9. Stem: Aluminum or lead-free brass and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: **3/4 inch (19 mm)**, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

G. Thermometers, Liquid in Glass, Lead Free - Plastic Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Flo Fab Inc**]
    c. [**Miljoco Corporation**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Weiss Instruments, Inc**]
    f. [**Weksler Glass Thermometer Corp.**]

2. Source Limitations: Provide liquid-in-glass, lead-free, plastic-case, compact-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Plastic**]; **6-inch (150-mm)** nominal size.
5. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[**or red**] organic liquid, mercury free.
7. Tube Background: Nonreflective with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Window: Glass or plastic.
9. Stem: Aluminum or lead-free brass and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: **3/4 inch (19 mm)**, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

H. Thermometers, Liquid in Glass, Lead Free - Metal Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Flo Fab Inc**]

c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**Trerice, H. O. Co**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide liquid-in-glass, lead-free, metal-case, industrial-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Cast aluminum**]; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
5. Case Form: [**Adjustable angle**][**Back angle**][**Straight**] unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[**or red**] organic liquid, mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Window: [Glass][Safety glass][acrylic plastic].
9. Stem: [**Aluminum**] and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

I. Thermometers, Liquid in Glass, Lead Free - Plastic Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ernst Flow Industries**]
    b. [**Marsh Bellofram**]
    c. [**Miljoco Corporation**]
    d. [**Palmer Wahl Instrumentation Group**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. [**Weiss Instruments, Inc**]
    g. [**Weksler Glass Thermometer Corp.**]
    h. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide liquid-in-glass, lead-free, plastic-case, industrial-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Plastic**]; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
5. Case Form: [**Adjustable angle**][**Back angle**][**Straight**] unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[**or red**] organic liquid, mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Window: [Glass][Safety glass][acrylic plastic].
9. Stem: [**Aluminum**][**Lead-free brass**][**Stainless steel**][**Aluminum, lead-free brass, or stainless steel**] and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

J. Thermometers, Light Activated, Lead Free - Direct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]
    c. [**Weiss Instruments, Inc**]
    d. [**Weksler Glass Thermometer Corp.**]
    e. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide light-activated, lead-free, direct-mounted thermometers from single manufacturer.
3. Case: [**Plastic**][**Metal**]; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
4. Scale Divisions: [**Deg F (deg C)**][**Deg F and deg C**].
5. Case Form: [**Adjustable angle**].
6. Connector: [**1-1/4 inches (32 mm)**], with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
7. Stem: [**Aluminum**] and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

8. Display: Digital.
9. Accuracy: Plus or minus **1 deg F (0.5 deg C)**.

K. Thermometers, Light Activated, Lead Free - Remote Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]

2. Source Limitations: Provide light-activated, lead-free, remote-mounted thermometers from single manufacturer.
3. Case: Plastic, for wall mounting.
4. Scale Divisions: [**Deg F (deg C)**][**Deg F and deg C**].
5. Sensor: Lead-free bulb and thermistor wire.

    a. Design for Thermowell Installation: Bare stem.

6. Display: Digital.
7. Accuracy: Plus or minus **1 deg F (0.5 deg C)**.

L. Thermowells, Lead Free:

1. Standard: ASME B40.200.

2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Lead-free copper.
4. Material for Use with Steel Piping: [**Type 304 stainless steel**][**Type 316 stainless steel**].
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: **NPS 1/2, NPS 3/4, or NPS 1 (DN 15, DN 20, or NPS 25)**, or as required to match threaded opening in pipe.
7. Internal Threads: Size and thread type as required to match thermometer mounting threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length to extend [**a minimum of 2 inches (50 mm) into fluid**][**one-third of pipe diameter**][**to center of pipe**][**to match thermometer stem length**].
10. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond finished insulation surface.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: [**Mixture of graphite and glycerin**].

M. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Ernst Flow Industries**]
    e. [**Flo Fab Inc**]
    f. [**Marsh Bellofram**]
    g. [**Miljoco Corporation**]
    h. [**Noshok**]
    i. [**Palmer Wahl Instrumentation Group**]
    j. [**REOTEMP Instrument Corporation**]
    k. [**Tel-Tru Manufacturing Company**]
    l. [**Trerice, H. O. Co**]
    m. [**WATTS; A Watts Water Technologies Company**]
    n. [**Weiss Instruments, Inc**]
    o. [**Weksler Glass Thermometer Corp.**]
    p. [**WIKA Instrument Corporation**]
    q. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Liquid-filled**][**Sealed**][**Open-front, pressure-relief**][**Solid-front, pressure-relief**] type(s); [**cast aluminum or drawn steel**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [Glass][Safety glass][plastic].

11. Ring: [**Metal**][**Brass**][**Stainless steel**].
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

N. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Flo Fab Inc**]
    d. [**Marsh Bellofram**]
    e. [**Miljoco Corporation**]
    f. [**Noshok**]
    g. [**Palmer Wahl Instrumentation Group**]
    h. [**REOTEMP Instrument Corporation**]
    i. [**Tel-Tru Manufacturing Company**]
    j. [**Trerice, H. O. Co**]
    k. [**Weiss Instruments, Inc**]
    l. [**Weksler Glass Thermometer Corp.**]
    m. [**WIKA Instrument Corporation**]
    n. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide dial-type, lead-free, direct-mounted, plastic-case pressure gauges from a single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Sealed**] type; [**plastic**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [Glass][Safety glass][acrylic plastic].
11. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

O. Pressure Gauges, Dial Type, Lead Free - Remote Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Ernst Flow Industries**]
    d. [**Flo Fab Inc**]
    e. [**Marsh Bellofram**]

f. [**Miljoco Corporation**]
g. [**Noshok**]
h. [**Palmer Wahl Instrumentation Group**]
i. [**REOTEMP Instrument Corporation**]
j. [**Tel-Tru Manufacturing Company**]
k. [**Trerice, H. O. Co**]
l. [**WATTS; A Watts Water Technologies Company**]
m. [**Weiss Instruments, Inc**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide dial-type, lead-free, remote-mounted, metal-case pressure gauges from a single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Liquid-filled**][**Sealed**] type; [**cast aluminum or drawn steel**][**metal**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter with [**back**][**front**] flange and holes for panel mounting.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 NPT pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [Glass][Safety glass][acrylic plastic].
11. Ring: [**Metal**][**Stainless steel**].
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

P. Pressure Gauges, Dial Type, Lead Free - Remote Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ashcroft Inc**]
   b. [**Flo Fab Inc**]
   c. [**Miljoco Corporation**]
   d. [**Noshok**]
   e. [**Palmer Wahl Instrumentation Group**]
   f. [**REOTEMP Instrument Corporation**]
   g. [**Tel-Tru Manufacturing Company**]
   h. [**Trerice, H. O. Co**]
   i. [**Weiss Instruments, Inc**]
   j. [**WIKA Instrument Corporation**]

2. Source Limitations: Provide dial-type, lead-free, remote-mounted, plastic-case pressure gauges from single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Sealed**] type; [**plastic**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter with [**back**][**front**] flange and holes for panel mounting.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or**

DN 15)][NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [psi (kPa)][**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [Glass][Safety glass][acrylic plastic].
11. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

Q. Gauge Attachments, Lead Free:

1. Snubbers: ASME B40.100, lead-free brass; with [NPS 1/4 (DN 8)][NPS 1/4 or NPS 1/2 (DN 8 or DN 15)][NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads and [**piston**][**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.
2. Valves: [**Lead-free brass ball**][**Lead-free brass or stainless steel needle**], with [NPS 1/4 (DN 8)][NPS 1/4 or NPS 1/2 (DN 8 or DN 15)][NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads.

R. Test Plugs, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**IMI Flow Design, Inc.**]
    b. [**Miljoco Corporation**]
    c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
    d. [**Peterson Equipment Co., Inc**]
    e. [**Trerice, H. O. Co**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Weiss Instruments, Inc**]
    h. [**Weksler Glass Thermometer Corp.**]

2. Source Limitations: Provide lead-free test plugs from single manufacturer.
3. Description: Test-station fitting made for insertion into piping tee fitting.
4. Body: Lead-free brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
5. Thread Size: [NPS 1/4 (DN 8)][NPS 1/2 (DN 15)], ASME B1.20.1 pipe thread.
6. Minimum Pressure and Temperature Rating: [500 psig at 200 deg F (3450 kPa at 93 deg C)].
7. Core Inserts: [**Chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber.

S. Test-Plug Kits, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Peterson Equipment Co., Inc**]

2. Source Limitations: Provide lead-free test-plug kits from single manufacturer.
3. Furnish [**one**] test-plug kit(s) containing [**one**][**two**] thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes

are to be of diameter to fit test plugs and of length to project into piping.

4. Low-Range Thermometer, Lead Free: Small, bimetallic insertion type with [1- to 2-inch- (25- to 51-mm-)] diameter dial and tapered-end sensing element. Dial range is to be at least [25 to 125 deg F (minus 4 to plus 52 deg C)].
5. High-Range Thermometer, Lead Free: Small, bimetallic insertion type with [1- to 2-inch- (25- to 51-mm-)] diameter dial and tapered-end sensing element. Dial range is to be at least [0 to 220 deg F (minus 18 to plus 104 deg C)].
6. Pressure Gauge, Lead Free: Small, lead-free Bourdon-tube insertion type with [2- to 3-inch- (51- to 76-mm-)] diameter dial and probe. Dial range is to be at least [0 to 200 psig (0 to 1380 kPa)].
7. Carrying Case: Metal or plastic, with formed instrument padding.

T. Sight Flow Indicators, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARCHON Industries, Inc**]
    b. [**Dwyer Instruments, Inc**]
    c. [**Ernst Flow Industries**]
    d. [**John C. Ernst Co., Inc.**]
    e. [**KOBOLD Instruments, Inc. - USA**]
    f. [**OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company**]

2. Source Limitations: Provide lead-free sight flow indicators from single manufacturer.
3. Description: Piping inline-installation device for visual verification of flow.
4. Construction: Lead-free bronze or stainless steel body, with sight glass and [**ball, flapper, or paddle wheel**] indicator, and threaded or flanged ends.
5. Minimum Pressure Rating: [125 psig (860 kPa)][150 psig (1034 kPa)].
6. Minimum Temperature Rating: [200 deg F (93 deg C)].
7. End Connections: [NPS 2 (DN 50) **and smaller, threaded**][NPS 2-1/2 (DN 65) **and larger, flanged**].

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS, GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.3 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

A. Install grooved-joint expansion joints to grooved-end steel piping.

3.4 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install [**one**][**two**] guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than [**four**] pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.5 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least [**five**] pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least [**four**] pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least [**four**] pipe fittings, including tee in main.

3.6 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch (25-mm)**][**2-inch (50-mm)**] annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [2 inches (50 mm)] above finished floor level.

3. Using [grout][silicone sealant], seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.7 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [grout][silicone sealant], seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.8 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.9 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.10 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.11 INSTALLATION OF METERS AND GAUGES

A. Install thermometer with thermowell at each required thermometer location.

B. Install thermowells in vertical position in piping tees.

C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

D. Install thermowells with extension on insulated piping.

E. Fill thermowells with heat-transfer medium.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks.

H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

I. Install remote-mounted pressure gauges on panel.

J. Install valve and snubber in piping for each pressure gauge for fluids.

K. Install test plugs in piping tees.

L. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.
5. Outlet side of hot-water-balancing valve.
6. Each main hot-water-recirculating line return pipe.

M. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.12 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.13 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.14 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.15 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**] annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**] annular clear space between piping

and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

    a. [Sleeves with waterstops][stack-sleeve fittings].

4. Interior Wall and Partitions:

    a. Sleeves without waterstops.

3.16 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, [**steel**][**cast brass**][**or split-casting brass**] with polished, chrome-plated finish.
3. Insulated Piping:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
    c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
    c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split casting, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

3.17 THERMOMETER, LEAD FREE, APPLICATION

A. Thermometers at inlet and outlet of each domestic water heater are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Metal**][**Plastic**] case, [**compact**][**industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Metal**][**Plastic**] case, [**compact**][**industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Metal**][**Plastic**] case, [**compact**][**industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each remote domestic water chiller are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Metal**][**Plastic**] case, [**compact**][**industrial**]-style, liquid-in-glass type.

4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

E. Thermometer stems are to be of length to match thermowell insertion length.

3.18 THERMOMETER, LEAD FREE, SCALE-RANGE APPLICATION

A. Scale Range for Domestic Cold-Water Piping:

1. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
2. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].

B. Scale Range for Domestic Hot-Water Piping:

1. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
2. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**].
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].

C. Scale Range for Domestic Cooled-Water Piping:

1. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
2. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].

D. Insert additional paragraphs for thermometer scale ranges and applications.

3.19 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each water service into building are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**] [**direct**][**remote**] mounted, metal case.
2. [**Sealed**] [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each water pressure-reducing valve are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**] [**direct**][**remote**] mounted, metal case.
2. [**Sealed**] [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each domestic water pump are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**] [**direct**][**remote**] mounted, metal case.
2. [**Sealed**] [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

3.20 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Water Service Piping:

1. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
2. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
3. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].

B. Scale Range for Domestic Water Piping:

1. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
2. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
3. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].
4. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].

C. Insert additional paragraphs for pressure-gauge scale ranges and applications.

END OF SECTION 22 05 00 00

SECTION 22 05 00 00A - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. TAB of domestic water system.
2. TAB of plumbing equipment:

a. Domestic water booster pumps.
b. Domestic hot-water in-line circulation pumps.
c. General-duty air compressors.
d. Sanitary sewage pumps.
e. Drainage pumps.
f. Laboratory air compressors.
g. Laboratory vacuum pumps.

3. Pipe-leakage test verification.
4. Testing, adjusting, and balancing of existing plumbing systems and equipment.

B. Related Requirements:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for TAB of HVAC.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. FFT: Fast Fourier transform.

C. INCE: Institute of Noise Control Engineering.

D. NC: Noise criteria.

E. NEBB: National Environmental Balancing Bureau.

F. RC: Room criteria.

G. TAB: Testing, adjusting, and balancing.

H. TABB: Testing, Adjusting, and Balancing Bureau.

I. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

J. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at [**Project site**]<**Insert location**> after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of [**14**]<**Insert number**> days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Requirements for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.
e. <**Insert additional agenda items as required**>.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, provide a summary report of the examination review required in "Examination" Article, if issues are discovered that may preclude the proper testing and balancing of the systems. Submit a summary report of the examination review required in "Examination" Article.

C. Strategies and Procedures Plan: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article, to be used and filled out by systems installers verifying that systems are ready for TAB.

E. Certified TAB Reports: Within [**14**][**21**][**30**]<**Insert number**> days of completion of testing and balancing work.

1. Submit one copy of the final TAB report to the design professional of record's firm. Provide [**five**]<**Insert number**> additional copies to Contractor.

F. Sample report forms.

G. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration and calibration interval.

1.5 QUALITY ASSURANCE

A. TAB Specialist Firm's Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist firm and certified by AABC.
2. TAB Technician: Employee of the TAB specialist firm and certified by AABC.

B. TAB Specialist Firm's Qualifications: Certified by [**NEBB**][**or**][**TABB**].

1. TAB Certified Professional: Employee of the TAB specialist firm and certified by [**NEBB**][**or**][**TABB**].
2. TAB Technician: Employee of the TAB specialist firm and certified by [**NEBB**][**or**][**TABB**].
3. TAB specialist firm is to be independent, third-party, and unaffiliated with Contractor.

C. Sound and Vibration Specialists: [**NEBB-certified Sound and Vibration Technician**][**TABB-certified Sound and Vibration Technician**][**INCE Board-certified professional**][**Vibration Institute Category I Certified Vibration Analyst**][**Vibration Institute Category II Certified Vibration Analyst**][**Vibration Institute Category III Certified Vibration Analyst**][**Vibration Institute Category IV Certified Vibration Analyst**][**or**][**Licensed professional engineer who specializes in acoustical engineering**]<**Insert sound and vibration certification**>.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

E. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.

F. ASHRAE 188 Compliance: Comply with balancing and report requirements in Section 8.3, "Balancing."

G. Code and Authorities Having Jurisdiction Compliance: Furnish TAB services that comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS
PART 3 - EXECUTION

3.1 TAB SPECIALIST FIRMS

A. Subject to compliance with requirements, [**engage one of the following**][**available TAB specialist firm that may be engaged include, but are not limited to, the following**]:

1. <**Insert TAB specialist firm's name**>.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in system designs that may preclude proper TAB of systems and equipment. Submit Contract

Documents Examination Report summary of findings.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Note the locations of devices that are not accessible for TAB.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

E. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

F. Verify with installing Contractor that startup strainer screens have been replaced with permanent screens and that all strainers have been cleaned.

G. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

H. Observe demonstration of operating safety interlocks and controls on plumbing equipment.

I. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Prepare system-readiness checklists of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Verify leakage and pressure tests on water distribution systems have been completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Water treatment is complete.
e. Systems are flushed, filled, and air purged.
f. Strainers are clean.
g. Control valves are functioning in accordance with the sequence of operation.
h. Shutoff and balance valves are 100 percent open.
i. [**Booster-**][**and**][**hot-water circulating**] pumps are operational and proper rotation is verified.
j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
k. Variable-frequency controllers' startup is complete, and safeties are verified.
l. Suitable access to balancing devices and equipment is provided.

2. Sanitary Sewage/Drainage System:

    a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
    b. Piping is complete.
    c. Sanitary sewage pumps/drainage pumps are operational.
    d. Control valves are functioning in accordance with the sequence of operation.
    e. Shutoff valves are 100 percent open.
    f. Suitable access to equipment is provided.

3. Compressed-Air System:

    a. Leakage and pressure tests on compressed air-distribution system have been satisfactorily completed in accordance with Div. 22 requirements.
    b. Piping is complete and all points of outlet are installed.
    c. Systems are flushed, filled, and air purged.
    d. Strainers are clean.
    e. Control valves are functioning in accordance with the sequence of operation.
    f. Shutoff and balance valves are 100 percent open.
    g. Compressors are operational and of proper rotation.
    h. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
    i. Variable-frequency controllers' startup is complete, and safeties are verified.
    j. Suitable access to balancing devices and equipment is provided,

4. Vacuum System:

    a. Leakage and pressure tests on vacuum system have been satisfactorily completed in accordance with Div. 22 requirements.
    b. Piping is complete and all points of inlet are installed.
    c. Systems are flushed, filled, and purged.
    d. Strainers are clean.
    e. Control valves are functioning in accordance with the sequence of operation.
    f. Shutoff and balance valves are 100 percent open.
    g. Vacuum pumps are operational and of proper rotation.
    h. Gauge connections are installed directly at vacuum pump inlet and outlet flanges prior to valves or strainers.
    i. Variable-frequency controllers' startup is complete, and safeties are verified.
    j. Note location of balancing devices that aren't accessible.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in [**AABC's "National Standards for Total System Balance"**][**ASHRAE 111**][**NEBB's "Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems"**][**SMACNA's "HVAC Systems - Testing, Adjusting & Balancing"**][**SMACNA's "TAB Procedural Guide"**] applicable to analogous domestic water system and plumbing equipment balancing in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Installing Contractor to Perform the Following:

    a. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.

b. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in [**inch-pound (IP**][**and**] units.

E. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.5 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Domestic water booster pumps.
3. Domestic water in-line pumps.
4. Domestic water heaters.
5. Sanitary sewage pumps.
6. Drainage pumps.
7. Air compressors.
8. Vacuum pumps.
9. <**Insert equipment**>.

3.6 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Cross-check the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' record Drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Check flow-control valves for proper position.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
6. Verify that motor controllers are equipped with properly sized thermal protection.
7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.7 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

A. Prepare test reports for air compressors and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Cross-check the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' record Drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:

1. Check remotest point of outlet for adequate pressure.
2. Check pressure-control valves for proper position.
3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
4. Verify that motor controllers are equipped with properly sized thermal protection.

D. Measure and record upstream and downstream pressure of pressure-reducing valves.

E. Check settings and operation of pressure-reducing valves. Record final settings.

F. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR VACUUM SYSTEMS

A. Prepare test reports for vacuum pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Cross-check the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' record Drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check remotest point of inlet for adequate vacuum.
2. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
3. Verify that motor controllers are equipped with properly sized thermal protection.

3.9 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

A. Adjust pumps to deliver total design flow.

1. Measure total water flow.

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, pump impellers are to be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

D. Verify that memory stops have been set.

3.10 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.11 PROCEDURES FOR MOTORS

A. Motors: [**1/2**]<**Insert value**> hp and larger; test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation. Verify and report Hz at maximum and minimum flows.

3.12 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. [**Measure and**]Record relief valve(s) pressure setting.
5. Capacity: Calculate in **Btu/h** **(kW)** of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

B. Gas- and Oil-Fired Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. [**Measure and**]Record relief valve(s) pressure setting.
5. Capacity: Calculate in **Btu/h** **(kW)** of heating output.
6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
8. Fan, motor, and motor controller operating data.

3.13 SOUND TESTS

A. After systems are balanced and Substantial Completion, with all systems operating at normal conditions and with all spaces completed and finished for occupancy, measure and record sound levels at [**five**][**10**][**15**]<**Insert number**> locations as designated by Architect. All building mechanical, electrical, and plumbing equipment, which may affect sound readings, must be operational.

B. Sound-Level Testing Meter Instrumentation - Minimum Requirements:

1. Portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.

2. Capable of showing fluctuations at minimum and maximum levels and measuring the equivalent continuous sound pressure level (Leq).
3. Capable of using one-third octave band filters to measure frequencies from 31.5 Hz to 8000 Hz.
4. Accuracy of plus/minus two decibels.
5. Current NIST-traceable annual calibration. Calibrate instruments prior to taking measurements and after taking measurements each day of use.

C. Test Procedures - Indoors:

1. Measure and record sound levels at the following rooms:

   a. <**Insert list of room numbers and names where sound testing is required**>.

2. For each room/location tested, select a measurement location that has the greatest anticipated sound level. If testing multiple locations for each room type, select at least one location that is near and at least one location that is remote from the predominant sound source.
3. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
4. Equipment is to be operating at design values.
5. Sound-testing firm is to have access to controls hardware, software, and onsite technical support at no cost to the sound-testing firm. The installing contractors are to provide a controlled, steady-state environment (flow, pressure, control, and temperature) during duration of sound testing.
6. Use a microphone suitable for the type of noise levels measured that is compatible with meter.
7. At each measurement location, record a set of background sound pressure levels, with fast time constant and minimum time duration of 60 seconds, in the eight unweighted octave bands [**63 Hz to 8000 Hz (NC)**][**31.5 Hz to 4000 Hz (RC)**] with the equipment off.
8. At each measurement location, record a set of sound pressure levels, with fast time constant and minimum time duration of 60 seconds, in the eight unweighted octave bands [**63 Hz to 8000 Hz (NC)**][**31.5 Hz to 4000 Hz (RC)**] with the equipment operating.
9. Take readings no closer than **36 inches (900 mm)** from a wall or from the operating equipment and approximately **48 inches (1200 mm)** from the floor, with the meter held or mounted on a tripod.

D. Reporting:

1. The final report is to contain the following information at a minimum:

   a. Report Title Page: Page indicating Project name, names of Project Architect, engineer, HVAC Contractor, and sound measurement firm with names, addresses, and telephone numbers.
   b. Report Certification Page: Page indicating Project name, sound measurement firm name, name of individual performing measurements, and all required sound technician certifications.
   c. Table of Contents: Identify report sections and total number of pages in each section.
   d. Report Summary/Remarks: Narrative description of system setup conditions, results, and deficiencies.
   e. Instrument Calibration Section: List of instruments to be used to verify the reported data, containing the name/type of each instrument, manufacturer, model number, serial number, calibration date and dates of use, and NIST-traceable calibration certificates.
   f. Sound Measurement Data Sheets: Record sound measurements on sound measurement report forms, indicating the decibel levels measured for both "background" and "building system operating" readings. Record each tested location on a separate NC or RC chart. Record the following information on the forms:

      1) Date and time of test.

2) Equipment Operational Parameters: Speed and frequency at time of measurements.
3) Indoor Measurements: Space location within the building, including floor level and room space number.
4) Outdoor Measurements: Location identifier such as location relative to equipment, building, or property line.
5) Indicate where measurements meet or exceed design criteria.

3.14 VIBRATION TESTS

A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than [**3**]<**Insert number**>[**for pumps and fans,**][**5**]<**Insert number**>[**for chillers and compressors**].

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter is to automatically identify engineering units, frequency resolution, filter bandwidth, amplitude, and frequency scale values.
3. The meter is to be able to measure machine vibration displacement in mils of deflection; velocity in inches per second (meters/sec); and acceleration in G's (or g-force), inches per second squared (G's, meters per second squared).
4. Calibration of instrument and transducer must be NIST traceable and must be current during the time period measurements are being made. Vibration instruments and transducers must have NIST-traceable calibration every 12 months. Verify calibration date is current for vibration meter before taking readings.

C. Pretest Procedures:

1. Before any vibration measurements are made, confirm that the following items have been completed and any deficiencies found are reported to the appropriate parties for remedy:

a. Verify that all vibration isolators are installed in accordance with respective manufacturer's written instructions.
b. Verify that piping and conduit penetrations through plumbing equipment room envelope are sealed, and that there is no rigid contact with building structure.
c. Inspect steel isolation bases for cracked welds and bending/twisting of steel members.
d. Inspect concrete isolation bases for cracked concrete. Check isolator retainer brackets to be sure they are not loose. Concrete base must be flat and true level.
e. Examine elastomeric isolators for cracks in the rubber and for loose bonds between the rubber and the steel plates and other steel components. Verify clearance is provided between bolts and the side of bolt holes to prevent short circuiting.
f. Examine steel spring isolators for loose or missing bolts, nuts, and lock washers. Verify springs are not overloaded or underloaded, completely collapsed, or cocked. Verify rubber or glass-fiber pad between bottom steel spring plate and the concrete/supporting structure is in place.
g. Inspect isolators that have seismic restraint devices to make sure that all shims have been removed and supportive nuts have been properly adjusted to allow for free floating of the isolated system.
h. Verify that seismic restraints are not preventing proper functioning of vibration isolation function.
i. Verify space under isolated bases are clean and free of debris that could cause short-circuiting.
j. Verify that shipping bolts associated with spring isolators have been removed so that they do not short-circuit the system.

k. Verify flexible piping, hoses, and expansion joint types, lengths, and locations are as specified.
l. Verify that electrical and control connections do not restrain movement of the vibration-isolated equipment.
m. Verify flexible connections between fans and ductwork "bellow" as designed when fans are operating.
n. Verify that hanger isolator rods are free of misalignment and not in rigid contact with the hanger housing.

D. Test Procedures:

1. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not adversely influence measurements of equipment being tested.
2. Observe if there is equipment in the building that might interfere with testing. Note the equipment to the construction manager and request resolution before testing begins.
3. Take measurements when exterior vibration sources, such as trains, roadway traffic, adjacent construction activities, and the like, are at a minimum level.
4. Attach and secure vibration transducer in accordance with the most current edition of [**NEBB's "Procedural Standards for Measurement of Sound and Vibration."**]<**Insert reference document.**>
5. Measure and record vibration levels [**in at least 1.25 Hz increments over a minimum frequency range of 5 to 1000 Hz**]<**Insert increment requirements**>.
6. Measure and record acceleration and/or velocity and/or displacement readings on equipment; bearing and equipment base in the vertical, horizontal, and axial planes; or as per-contract specifications, where measurements can be performed safely and where measurement locations are accessible.

    a. Pumps:

        1) Pump Bearing: Drive end and opposite end.
        2) Motor Bearing: Drive end and opposite end.
        3) Equipment Base: Top and side, within **6 inches (152 mm)** of one isolator.
        4) Building: Floor adjacent to pump/motor, within **6 inches (152 mm)** of one isolator; vertical axis only.

    b. Compressors:

        1) Compressor Bearing: Drive end and opposite end.
        2) Motor Bearing: Drive end and opposite end.
        3) Equipment Base: Top and side, within **6 inches (152 mm)** of one isolator.
        4) Building: Floor adjacent to compressor/motor, within **6 inches (152 mm)** of one isolator; vertical axis only.

7. FFT Analyzer Settings:

    a. Windowing: Hanning.
    b. Averages: At least two.
    c. Frequency Range: 5 to 1,000 Hz (300 to 60,000 rpm).
    d. Frequency Resolution: At least 1.25 Hz (75 rpm).
    e. Line of Resolution: At least 800.
    f. Detection: Peak, peak-to-peak, or RMS.
    g. Averaging: Exponential.

E. Reporting:

1. Vibration Measurement Report Forms:

    a. For each measurement location, record vibration measurements on appropriate test forms, showing the following information:

        1) Date of test.
        2) Equipment designation, location, motor horsepower, and equipment operational parameters (speed/frequency) at time of test.
        3) Measured acceleration, [**in units of g's (g-force), inches/seconds squared (meters/seconds squared)**]<**Insert units of measure**>.
        4) Measured deplacement, [**in units of inches, mils (millimeters)**]<**Insert units of measure**>.
        5) Vibration level plot of vibration amplitude versus frequency for each measurement location.
        6) Verify vibration amplitude level plot versus frequency for each measurement location.

2. Verify actual vibration against vibration limits. Follow the[**General Machinery Vibration Severity Chart**] or[**Vibration Acceleration General Severity Chart**] from [**ASHRAE Handbook - "HVAC Applications," Ch. "Noise and Vibration Control"**][**NEBB's "Procedural Standard for Measurement of Sound and Vibration"**][**or**][**AABC's "National Standards for Total System Balance."**] Acceptable levels of vibration are normally "smooth" to "good."
3. Include General Machinery Vibration Severity Chart with all conditions plotted.
4. Test each bearing on motor, pump, and compressor as required. Track and record vibration levels from rotating component through casing to base.
5. Include horizontal-vertical-axial measurements for tests.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record flows, temperatures, and pressures of each piece of equipment. Compare the values to design or nameplate information, where information is available.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check bearings and other lubricated parts for proper lubrication.
5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB after Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Bearings and other parts are properly lubricated.
3. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated system flows of the renovated work to the measured flows and determine the new pump speed.
2. Verify that the indicated system flows of the renovated work result in velocities and pump speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the system flow rates by more than [**5**]<**Insert number**> percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is [**5**]<**Insert number**> percent or less, equipment adjustments are not required.

3.16 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**>. If design value is less than **10 gpm (0.63 L/s)**, flow rate is within 10 percent.
2. Compressed-Air Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**>. If design value is less than **10 gpm (0.63 L/s)**, flow rate is within 10 percent.
3. Vacuum Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**>.

3.17 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare [**weekly**][**biweekly**][**monthly**]<**Insert time interval**> progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL TESTING AND BALANCING REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB specialist firm and technician.
3. Project name.
4. Project location.
5. Project Architect's name, firm, and address.
6. Project engineer's name, firm, and address.
7. Project Contractor's name, firm, and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Gas- and Oil-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Fuel type in input data.
    g. Output capacity in **Btu/h (kW)**.
    h. Ignition type.
    i. Burner-control types.
    j. Motor horsepower and speed.
    k. Motor volts, phase, and hertz.
    l. Motor full-load amperage and service factor.
    m. Sheave make, size in **inches (mm)**, and bore.
    n. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.

2. Test Data (Indicated and Actual Values):

    a. Total airflow rate in **cfm (L/s)**.
    b. Entering-water temperature in **deg F (deg C)**.

c. Leaving-water temperature in deg F (deg C).
d. Low-fire fuel input in Btu/h (kW).
e. High-fire fuel input in Btu/h (kW).
f. High-temperature-limit setting in deg F (deg C).
g. Operating set point in Btu/h (kW).
h. Heating value of fuel in Btu/h (kW).

F. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Model number and unit size.
d. Manufacturer's serial number.
e. Output capacity in Btu/h (kW).
f. Number of stages.
g. Connected volts, phase, and hertz.
h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h (kW).
b. Entering-water temperature in deg F (deg C).
c. Leaving-water temperature in deg F (deg C).
d. High-temperature-limit setting in deg F (deg C).
e. Operating set point in deg F (deg C).
f. Voltage at each connection.
g. Amperage for each phase.

G. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm (L/s).
g. Water-pressure differential in feet of head or psig (kPa).
h. Required net positive suction head in feet of head or psig (kPa).
i. Pump speed.
j. Impeller diameter in inches (mm).
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in **feet of head or psig (kPa)**.
b. Pump shutoff pressure in **feet of head or psig (kPa)**.
c. Actual impeller size in **inches (mm)**.
d. Full-open flow rate in **gpm (L/s)**.
e. Full-open pressure in **feet of head or psig (kPa)**.
f. Final discharge pressure in **feet of head or psig (kPa)**.
g. Final suction pressure in **feet of head or psig (kPa)**.
h. Final total pressure in **feet of head or psig (kPa)**.
i. Final water flow rate in **gpm (L/s)**.
j. Voltage at each connection.
k. Amperage for each phase.

H. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.19 VERIFICATION OF TAB REPORT

A. The TAB specialist firm's test and balance technician is to conduct the final verification in the presence of [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**].

B. [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**] are to randomly select measurements, documented in the final report, to be rechecked. Rechecking is to be limited to the lesser of either [**10**]<**Insert number**> percent of the total measurements recorded or the extent of measurements that can be accomplished in [**a normal 8-hour business day**]<**Insert value**>.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements are to be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than [**10**][**20**]<**Insert number**> percent of the total measurements checked during the final inspection, the TAB are to considered incomplete and are to be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists are to recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. Track all changes to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB Work.

F. Prepare test and inspection reports.

3.20 REVERIFICATION

A. TAB specialist firm technicians are to recheck all measurements and make adjustments as required to complete the balancing. Revise the final report and request a second verification.

B. If the second verification also fails, [**Owner**][**Architect**] may contact [**AABC headquarters regarding the AABC National Performance Guaranty**][**TABB Quality Assurance Program, Customer Complaint Procedures**]<**Insert guaranty organization**>.

3.21 ADDITIONAL TESTS

A. Within [**90**]<**Insert number**> days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 22 05 00 00A

Task	Specification	Specification Description
22 05 19 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing

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SECTION 22 05 23 00 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Gate valves.
5. Chainwheels.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer.

C. FKM: Fluoroelastomer.

D. NBR: Nitrile butadiene rubber (also known as Buna-N).

E. NRS: Nonrising stem.

F. OS&Y: Outside screw and yoke.

G. PTFE: Polytetrafluoroethylene.

H. RPTFE: Reinforced polytetrafluoroethylene.

I. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include material descriptions and dimensions of individual components.
b. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.

3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.
6. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic-water piping valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372; or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.
6. ASME B16.22 for wrought-copper solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves [**NPS 4 (DN 100)**] and larger.
2. Hand Lever: For quarter-turn ball valves smaller than [**NPS 4 (DN 100)**].

I. Valves in Insulated Piping:

1. Provide **2-inch (50-mm)** extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 BALL VALVES, LEAD FREE

A. Ball Valves, Lead Free, Threaded Ends - Brass, One Piece:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bonomi North America, Inc.**]
   b. [**KITZ Corporation**]
   c. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: One piece.
5. Body Material: Forged brass or bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Brass or stainless steel.
9. Ball: Chrome-plated brass or stainless steel.
10. Port: Reduced.

B. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Bonomi North America, Inc.**]
   e. [**Center Line; a Crane Co. brand**]
   f. [**DynaQuip Controls**]
   g. [**FNW; Ferguson Enterprises, Inc.**]
   h. [**Hammond Valve**]
   i. [**Jenkins Valves; a Crane Co. brand**]

j. [**Jomar Valve**]
k. [**KITZ Corporation**]
l. [**Lance Valves**]
m. [**Marwin Valve; Richards Industries**]
n. [**Milwaukee Valve Company**]
o. [**Mueller Streamline Co.; a company of Mueller Industries**]
p. [**Red-White Valve Corp.**]
q. [**Stockham; a Crane Co. brand**]
r. [**Viega LLC**]
s. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

C. Ball Valves, Lead Free, Press Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bonomi North America, Inc.**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Milwaukee Valve Company**]
k. [**Stockham; a Crane Co. brand**]
l. [**Viega LLC**]
m. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110, MSS SP-145, IAPMO/ANSI Z1157.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Seats: PTFE or RPTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: NBR or EPDM.

D. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Stainless

Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**Jomar Valve**]
    g. [**KITZ Corporation**]
    h. [**Lance Valves**]
    i. [**Marwin Valve; Richards Industries**]
    j. [**Milwaukee Valve Company**]
    k. [**Red-White Valve Corp.**]
    l. [**Stockham; a Crane Co. brand**]
    m. [**Viega LLC**]
    n. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

E. Ball Valves, Lead Free, Press Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Center Line; a Crane Co. brand**]
    d. [**Hammond Valve**]
    e. [**Jomar Valve**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**Viega LLC**]
    l. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110, MSS SP-145, and IAPMO/ANSI Z1157.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.

6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Seats: PTFE or RPTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.
12. O-Ring Seal: NBR or EPDM.

F. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Center Line; a Crane Co. brand**]
    e. [**FNW; Ferguson Enterprises, Inc.**]
    f. [**Hammond Valve**]
    g. [**Jomar Valve**]
    h. [**KITZ Corporation**]
    i. [**Lance Valves**]
    j. [**Milwaukee Valve Company**]
    k. [**Red-White Valve Corp.**]
    l. [**Stockham; a Crane Co. brand**]
    m. [**Viega LLC**]
    n. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Regular.

G. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Center Line; a Crane Co. brand**]
    e. [**Hammond Valve**]
    f. [**Jomar Valve**]

g. [**KITZ Corporation**]
h. [**Lance Valves**]
i. [**Marwin Valve; Richards Industries**]
j. [**Milwaukee Valve Company**]
k. [**Neles Corporation**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. [**Viega LLC**]
o. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Brass or bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

H. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bonomi North America, Inc.**]
b. [**Jomar Valve**]
c. [**Marwin Valve; Richards Industries**]
d. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

I. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DynaQuip Controls**]
b. [**Marwin Valve; Richards Industries**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.

5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

J. Ball Valves, Lead Free, Threaded Ends - Bronze, One Piece with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**NIBCO INC.**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. [**Zurn Industries, LLC**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: One piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Reduced.

K. Ball Valves, Lead Free, Threaded Ends - Bronze, One Piece with Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**NIBCO INC.**]
    b. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: One piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Reduced.

L. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Bonomi North America, Inc.**]
c. [**Center Line; a Crane Co. brand**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. [**Viega LLC**]
k. [**WATTS; A Watts Water Technologies Company**]
l. [**Zurn Industries, LLC**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

M. Ball Valves, Lead Free, Press Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Center Line; a Crane Co. brand**]
c. [**Hammond Valve**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. [**Red-White Valve Corp.**]
g. [**Stockham; a Crane Co. brand**]
h. [**Viega LLC**]
i. [**Zurn Industries, LLC**]

2. Standards: MSS SP-110, MSS SP-145, and IAPMO/ANSI Z1157.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Seats: PTFE or RTPFE.
9. Stem: Bronze or brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: EPDM or NBR.

N. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Center Line; a Crane Co. brand**]
c. [**DynaQuip Controls**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. [**Viega LLC**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

O. Ball Valves, Lead Free, Threaded Ends - Bronze, Two Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DynaQuip Controls**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Red-White Valve Corp.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze or brass.

9. Ball: Chrome-plated brass.
10. Port: Regular.

P. Ball Valves, Lead Free, Threaded Ends - Bronze, Two Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Center Line; a Crane Co. brand**]
    c. [**DynaQuip Controls**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**Jomar Valve**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**Viega LLC**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

Q. Ball Valves, Lead Free, Threaded Ends - Bronze, Three Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

R. Ball Valves, Lead Free, Threaded Ends - Bronze, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**NIBCO INC.**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

S. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Regular.

T. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.

8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

U. Ball Valves, Lead Free, Flanged or Threaded Ends - Steel, with Full Port, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**DynaQuip Controls**]
    c. [**FNW; Ferguson Enterprises, Inc.**]
    d. [**Hammond Valve**]
    e. [**Jomar Valve**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**Neles Corporation**]
    i. [**NIBCO INC.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**Viega LLC**]
    l. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-72 and MSS SP-110.
3. CWP Rating: **285 psig (1964 kPa)**.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

V. Ball Valves, Lead Free, Flanged or Threaded Ends - Steel, with Regular Port, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**FNW; Ferguson Enterprises, Inc.**]
    c. [**Hammond Valve**]
    d. [**Jomar Valve**]
    e. [**Lance Valves**]
    f. [**Milwaukee Valve Company**]
    g. [**Neles Corporation**]
    h. [**NIBCO INC.**]
    i. [**Stockham; a Crane Co. brand**]

2. Standards: MSS SP-72 and MSS SP-110.
3. CWP Rating: **285 psig (1964 kPa)**.
4. Body Design: Uni-body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.

7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

W. Ball Valves, Lead Free, Flanged or Threaded Ends - Iron, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Sure Flow Equipment Inc**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]

2. Standards: MSS SP-72, MSS SP-110, and MSS SP-145.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: ASTM A126, gray iron.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel.
10. Port: Full.

X. Ball Valves, Lead Free, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Guardian Worldwide LLC.**]
    d. [**Jomar Valve**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

Y. Ball Valves, Lead Free, Press Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Jomar Valve**]

2. Standards: MSS SP-110, MSS SP-145, IAPMO PS-117, and ICC-ES LC1002.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Seats: PTFE.
9. Stem: Type 316 stainless steel.
10. Ball: Type 316 stainless steel.
11. Port: Full.
12. O-Ring Seal: EPDM or NBR.

Z. Ball Valves - CPVC, Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**GF Piping Systems: Georg Fischer LLC**]
e. [**Hayward Flow Control; Hayward Industries, Inc.**]
f. [**IPEX USA LLC**]
g. [**Jomar Valve**]
h. [**Red-White Valve Corp.**]
i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]

2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
4. Body Material: CPVC.
5. Body Design: Union type.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
8. Ball: CPVC, full port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

AA. Ball Valves - CPVC, Non-Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**IPEX USA LLC**]
e. [**Jomar Valve**]
f. [**Red-White Valve Corp.**]
g. [**Spears Manufacturing Company**]

2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)**. See Part 3 ball valve schedule articles.
4. Body Material: CPVC.
5. Body Design: Non-union type.
6. End Connections: Socket or threaded.
7. Ball: CPVC, full or reduced port.
8. Seals: PTFE or EPDM-rubber O-rings.
9. Handle: Tee shaped.

BB. Ball Valves - PVC, Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**GF Piping Systems: Georg Fischer LLC**]
e. [**Hayward Flow Control; Hayward Industries, Inc.**]
f. [**IPEX USA LLC**]
g. [**Jomar Valve**]
h. [**Red-White Valve Corp.**]
i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]

2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
4. Body Material: PVC.
5. Body Design: Union type.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable union with socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
8. Ball: PVC, full port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

CC. Ball Valves - PVC, Non-Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**IPEX USA LLC**]
e. [**Jomar Valve**]
f. [**Red-White Valve Corp.**]
g. [**Spears Manufacturing Company**]

2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature.
4. Body Material: PVC.
5. Body Design: Non-union type.
6. End Connections: Socket or threaded.
7. Ball: PVC, full or reduced port.
8. Seals: PTFE or EPDM-rubber O-rings.
9. Handle: Tee shaped.

2.4 BALL VALVES, GENERAL PURPOSE

A. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**DynaQuip Controls**]
f. [**FNW; Ferguson Enterprises, Inc.**]
g. [**Hammond Valve**]
h. [**Jenkins Valves; a Crane Co. brand**]
i. [**Jomar Valve**]
j. [**KITZ Corporation**]
k. [**Lance Valves**]
l. [**Legend Valve & Fitting, Inc**]
m. [**Marwin Valve; Richards Industries**]
n. [**Milwaukee Valve Company**]
o. [**Red-White Valve Corp.**]
p. [**Siemens Industry, Inc., Building Technologies Division**]
q. [**Stockham; a Crane Co. brand**]
r. [**Viega LLC**]
s. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-110.
3. SWP Rating: **150 psig (1035 kPa)**.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Brass.

10. Ball: Chrome-plated brass.
11. Port: Full.

B. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**DynaQuip Controls**]
    f. [**FNW; Ferguson Enterprises, Inc.**]
    g. [**Hammond Valve**]
    h. [**Jamesbury; a brand of Valmet**]
    i. [**Jenkins Valves; a Crane Co. brand**]
    j. [**Jomar Valve**]
    k. [**KITZ Corporation**]
    l. [**Lance Valves**]
    m. [**Legend Valve & Fitting, Inc**]
    n. [**Marwin Valve; Richards Industries**]
    o. [**Milwaukee Valve Company**]
    p. [**Red-White Valve Corp.**]
    q. [**RuB Inc**]
    r. [**Siemens Industry, Inc., Building Technologies Division**]
    s. [**Stockham; a Crane Co. brand**]
    t. [**Viega LLC**]
    u. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-110.
3. SWP Rating: **150 psig (1035 kPa)**.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

C. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-110.
3. SWP Rating: **150 psig (1035 kPa)**.
4. CWP Rating: **600 psig (4140 kPa)**.

5. Body Design: Three piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered ends. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.

D. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DynaQuip Controls**]
    b. [**Marwin Valve; Richards Industries**]
    c. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-110.
3. SWP Rating: **150 psig (1035 kPa)**.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Three piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

E. Ball Valves, Threaded Ends - Bronze, Two Piece, Safety Exhaust:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**DynaQuip Controls**]
    c. [**Lance Valves**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **200 psig (1380 kPa)** or other pressure. See Part 3 ball valve schedule articles.
4. Body Design: Two piece.
5. Body Material: Bronze, ASTM B584, Alloy C844.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.
10. Port: Full.

F. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jamesbury; a brand of Valmet**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Milwaukee Valve Company**]
i. [**NIBCO INC.**]
j. [**Stockham; a Crane Co. brand**]
k. [**Viega LLC**]
l. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-72.
3. CWP Rating: **285 psig (1964 kPa)**.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

G. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jamesbury; a brand of Valmet**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Milwaukee Valve Company**]
i. [**NIBCO INC.**]
j. [**Stockham; a Crane Co. brand**]
k. [**Viega LLC**]
l. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-72.
3. CWP Rating: **720 psig (4960 kPa)**.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

H. Ball Valves, Flanged Ends - Iron, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-72.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: ASTM A126, gray iron.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel.
10. Port: Full.

I. Ball Valves, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Hammond Valve**]
   e. [**Jomar Valve**]

2. Standard: MSS SP-110.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

2.5 BUTTERFLY VALVES, LEAD FREE

A. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]

b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)**, or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

B. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]

o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)**, or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

C. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**WATTS; A Watts Water Technologies Company**]
y. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 12 (DN 300) and Smaller: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See

Part 3 butterfly valve schedule articles.

4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

D. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Center Line; a Crane Co. brand**]
    d. [**DeZURIK**]
    e. [**DynaQuip Controls**]
    f. [**Flo Fab Inc**]
    g. [**FNW; Ferguson Enterprises, Inc.**]
    h. [**Hammond Valve**]
    i. [**Jamesbury; a brand of Valmet**]
    j. [**Jenkins Valves; a Crane Co. brand**]
    k. [**Jomar Valve**]
    l. [**Kennedy Valve Company; a division of McWane, Inc.**]
    m. [**KITZ Corporation**]
    n. [**Lance Valves**]
    o. [**Legend Valve & Fitting, Inc**]
    p. [**Milwaukee Valve Company**]
    q. [**NIBCO INC.**]
    r. [**Norriseal**]
    s. [**Red-White Valve Corp.**]
    t. [**Stockham; a Crane Co. brand**]
    u. [**Sure Flow Equipment Inc**]
    v. [**Viega LLC**]
    w. [**WATTS; A Watts Water Technologies Company**]
    x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

E. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

F. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]

m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**WATTS; A Watts Water Technologies Company**]
y. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

G. Butterfly Valves, Lead Free, Grooved End - Ductile Iron, 175 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Hammond Valve**]
c. [**Kennedy Valve Company; a division of McWane, Inc.**]
d. [**NIBCO INC.**]
e. [**Norriseal**]
f. [**Red-White Valve Corp.**]
g. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]
j. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **175 psig (1200 kPa)**.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.

H. Butterfly Valves, Lead Free, Grooved End - Ductile Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
j. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
k. [**Victaulic Company**]
l. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: **300 psig (2070 kPa)**.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.

I. Butterfly Valves, Lead Free, Grooved End - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
e. [**Victaulic Company**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: **300 psig (2070 kPa)**.
4. CWP Rating, NPS 10 (DN 250) and Larger: **200 psig (1380 kPa)**.
5. Body Material: Type 316 stainless steel, ASTM A743/A743M.
6. Ends: Grooved.
7. Stem: Type 416 stainless steel.
8. Disc: Type 316 stainless steel or ductile iron, encapsulated with Grade "EN" EPDM.
9. Seat: EDPM.

J. Butterfly Valves - CPVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Colonial Engineering, Inc.**]

c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**NIBCO INC.**]
f. [**Spears Manufacturing Company**]
g. [**Thermoplastic Valves, Inc**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 butterfly valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Flangeless (wafer) type.
5. Seat: EPDM rubber.
6. Seals: PTFE or EPDM-rubber O-rings.
7. Disc: CPVC.
8. Stem: Stainless steel.
9. Handle: Lever.

K. Butterfly Valves - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**ASC Engineered Solutions**]
d. [**Colonial Engineering, Inc.**]
e. [**GF Piping Systems: Georg Fischer LLC**]
f. [**Hayward Flow Control; Hayward Industries, Inc.**]
g. [**IPEX USA LLC**]
h. [**Legend Valve & Fitting, Inc**]
i. [**NIBCO INC.**]
j. [**Spears Manufacturing Company**]
k. [**Thermoplastic Valves, Inc**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 butterfly valve schedule articles.
3. Body Material: PVC.
4. Body Design: Flangeless (wafer) type.
5. Seat: EPDM rubber.
6. Seals: PTFE or EPDM-rubber O-rings.
7. Disc: PVC.
8. Stem: Stainless steel.
9. Handle: Lever.

2.6 BUTTERFLY VALVES, GENERAL PURPOSE

A. Butterfly Valves, Single Flange (Lug Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

B. Butterfly Valves, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]

o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

C. Butterfly Valves, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**WATTS; A Watts Water Technologies Company**]
y. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.

3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

D. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Center Line; a Crane Co. brand**]
    d. [**DeZURIK**]
    e. [**DynaQuip Controls**]
    f. [**Flo Fab Inc**]
    g. [**FNW; Ferguson Enterprises, Inc.**]
    h. [**Hammond Valve**]
    i. [**Jamesbury; a brand of Valmet**]
    j. [**Jenkins Valves; a Crane Co. brand**]
    k. [**Jomar Valve**]
    l. [**Kennedy Valve Company; a division of McWane, Inc.**]
    m. [**KITZ Corporation**]
    n. [**Lance Valves**]
    o. [**Legend Valve & Fitting, Inc**]
    p. [**Milwaukee Valve Company**]
    q. [**NIBCO INC.**]
    r. [**Norriseal**]
    s. [**Red-White Valve Corp.**]
    t. [**Stockham; a Crane Co. brand**]
    u. [**Sure Flow Equipment Inc**]
    v. [**Viega LLC**]
    w. [**WATTS; A Watts Water Technologies Company**]
    x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

E. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

F. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]

l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
s. [**NIBCO INC.**]
t. [**Norriseal**]
u. [**Red-White Valve Corp.**]
v. [**Stockham; a Crane Co. brand**]
w. [**Sure Flow Equipment Inc**]
x. [**Viega LLC**]
y. [**WATTS; A Watts Water Technologies Company**]
z. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

G. Butterfly Valves, Grooved End - Ductile Iron, 175 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
j. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
k. [**Victaulic Company**]
l. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **175 psig (1200 kPa)**.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: NBR.

H. Butterfly Valves, Grooved End - Ductile Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
    c. [**Hammond Valve**]
    d. [**Kennedy Valve Company; a division of McWane, Inc.**]
    e. [**NIBCO INC.**]
    f. [**Norriseal**]
    g. [**Red-White Valve Corp.**]
    h. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
    j. [**Victaulic Company**]
    k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: **300 psig (2070 kPa)**.
4. Body Material: Coated, ductile iron
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: NBR.

I. Butterfly Valves, Grooved End - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**ASC Engineered Solutions**]
    d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    e. [**Victaulic Company**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: **300 psig (2070 kPa)**.
4. Body Material: Type 316 stainless steel, ASTM A743/A743M.
5. Ends: Grooved.
6. Stem: Type 416 stainless steel.
7. Disc: Type 316 stainless steel.
8. Seat: NBR.

2.7 CHECK VALVES, LEAD FREE

A. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**Val-Matic Valve & Manufacturing Corp.**]
    m. [**Victaulic Company**]

2. Standard: MSS SP-80, Type 3.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: Bronze.

B. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 4.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: PTFE.

C. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Crane Fluid Systems; Crane Co.**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**Jomar Valve**]
    g. [**Lance Valves**]
    h. [**Milwaukee Valve Company**]
    i. [**NIBCO INC.**]
    j. [**Powell Valves**]
    k. [**Red-White Valve Corp.**]
    l. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 3.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: Bronze.

D. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**FNW; Ferguson Enterprises, Inc.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Lance Valves**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]
    h. [**Powell Valves**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 4.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: PTFE.

E. Check Valves, Lead Free, Swing Type, Press Ends - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
d. [**Hammond Valve**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]

2. Standards: MSS SP-80 and MSS SP-139.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B584, bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Disc: Brass or bronze.

F. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
e. [**Cooper Valves**]
f. [**Crane Fluid Systems; Crane Co.**]
g. [**DeZURIK**]
h. [**GA Industries, Inc**]
i. [**Hammond Valve**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Milwaukee Valve Company**]
p. [**Powell Valves**]
q. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.

G. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Nonmetallic-to-Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ASC Engineered Solutions**]
b. [**Cooper Valves**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**DeZURIK**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**KITZ Corporation**]
g. [**Lance Valves**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Composition.
8. Seat Ring: Bronze.
9. Disc Holder: Bronze.
10. Disc: PTFE.
11. Gasket: Asbestos free.

H. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Metal Seats, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cooper Valves**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**GA Industries, Inc**]
g. [**Hammond Valve**]
h. [**Jenkins Valves; a Crane Co. brand**]
i. [**KITZ Corporation**]
j. [**Lance Valves**]
k. [**Milwaukee Valve Company**]
l. [**Powell Valves**]
m. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.

I. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Lever- and Spring-

Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crispin Valve**]
    e. [**DeZURIK**]
    f. [**GA Industries, Inc**]
    g. [**Kennedy Valve Company; a division of McWane, Inc.**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closure Control: Factory-installed exterior lever and weight.

J. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Lever- and Weight-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**ASC Engineered Solutions**]
    c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    d. [**Cooper Valves**]
    e. [**Crispin Valve**]
    f. [**DeZURIK**]
    g. [**GA Industries, Inc**]
    h. [**Kennedy Valve Company; a division of McWane, Inc.**]
    i. [**Milwaukee Valve Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closure Control: Factory-installed exterior lever and weight.

K. Check Valves, Lead Free, Swing Type, Grooved Ends - Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**ASC Engineered Solutions**]
c. [**DeZURIK**]
d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
e. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
f. [**Victaulic Company**]

2. CWP Rating: **300 psig (2070 kPa)**.
3. Body Material: ASTM A536, ductile iron.
4. Seat: EPDM.
5. Disc: Spring operated, ductile iron or stainless steel.

L. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Milwaukee Valve Company**]
m. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
n. [**Val-Matic Valve & Manufacturing Corp.**]
o. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

M. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**GA Industries, Inc**]

e. [**KITZ Corporation**]
f. [**Metraflex Company (The)**]
g. [**Milwaukee Valve Company**]
h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
i. [**Val-Matic Valve & Manufacturing Corp.**]
j. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

N. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
m. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

O. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**GA Industries, Inc**]
e. [**Hilton Valves**]
f. [**KITZ Corporation**]
g. [**Metraflex Company (The)**]
h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

P. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Cooper Valves**]
    c. [**DeZURIK**]
    d. [**DFT Inc.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Keckley Company**]
    g. [**Metraflex Company (The)**]
    h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
    i. [**Val-Matic Valve & Manufacturing Corp.**]
    j. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

Q. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DFT Inc.**]
    b. [**Flomatic Valves; Flomatic Corporation**]
    c. [**Metraflex Company (The)**]
    d. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
    e. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: MSS SP-125.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

R. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Cooper Valves**]
c. [**Crispin Valve**]
d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Keckley Company**]
g. [**Metraflex Company (The)**]
h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
i. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

S. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Metraflex Company (The)**]

2. Standard: MSS SP-125.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

T. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cooper Valves**]
c. [**DeZURIK**]
d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Val-Matic Valve & Manufacturing Corp.**]
g. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.

6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

U. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: MSS SP-125.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

V. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**GA Industries, Inc**]
   f. [**Val-Matic Valve & Manufacturing Corp.**]
   g. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

W. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: MSS SP-125.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.

5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

X. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cooper Valves**]
    b. [**DeZURIK**]
    c. [**DFT Inc.**]
    d. [**Flomatic Valves; Flomatic Corporation**]
    e. [**Val-Matic Valve & Manufacturing Corp.**]
    f. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Y. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DFT Inc.**]
    b. [**Flomatic Valves; Flomatic Corporation**]
    c. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: MSS SP-125.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Z. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cooper Valves**]
    b. [**DeZURIK**]
    c. [**DFT Inc.**]
    d. [**Flomatic Valves; Flomatic Corporation**]
    e. [**Victaulic Company**]

2. Standard: MSS SP-125.

3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

AA. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DFT Inc.**]
    b. [**Flomatic Valves; Flomatic Corporation**]
    c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]

2. Standard: MSS SP-125.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

BB. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Anvil; an ASC Engineered Solution**]
    c. [**DeZURIK**]
    d. [**Flo Fab Inc**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Jomar Valve**]
    g. [**Keckley Company**]
    h. [**Lance Valves**]
    i. [**Metraflex Company (The)**]
    j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: Bronze.

CC. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**DeZURIK**]
d. [**Jomar Valve**]
e. [**Keckley Company**]
f. [**Lance Valves**]
g. [**Metraflex Company (The)**]
h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
i. [**Stockham; a Crane Co. brand**]
j. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: Bronze.

DD. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Keckley Company**]
   d. [**Stockham; a Crane Co. brand**]
   e. [**Sure Flow Equipment Inc**]
   f. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: API 594.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: Bronze.

EE. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Keckley Company**]
   d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   e. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: Bronze.

FF. Check Valves, Lead Free, Single-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Flowserve Corporation**]
    b. [**GA Industries, Inc**]
    c. [**Jomar Valve**]
    d. [**Keckley Company**]

2. Standard: API 594.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Wafer, single spring-loaded plate.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

GG. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Flomatic Valves; Flomatic Corporation**]
    b. [**Keckley Company**]
    c. [**Stockham; a Crane Co. brand**]
    d. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

HH. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DeZURIK**]
    b. [**Keckley Company**]
    c. [**Stockham; a Crane Co. brand**]
    d. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

II. Check Valves, Lead Free, Single-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Flowserve Corporation**]
    b. [**GA Industries, Inc**]
    c. [**Jomar Valve**]
    d. [**Keckley Company**]
    e. [**Victaulic Company**]

2. Standard: API 594.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: Wafer, single spring-loaded plate.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

JJ. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jomar Valve**]
    b. [**Keckley Company**]
    c. [**Stockham; a Crane Co. brand**]
    d. [**Sure Flow Equipment Inc**]
    e. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: API 594.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

KK. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Keckley Company**]
    b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    c. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

LL. Check Valves, Lead Free - CPVC, Union-Type Ball Check:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**NIBCO INC.**]
g. [**Spears Manufacturing Company**]
h. [**Thermoplastic Valves, Inc**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 check valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Union-type ball check.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
7. Ball: CPVC.
8. Seals: EPDM- or FKM-rubber O-rings.

MM. Check Valves, Lead Free - PVC, Union-Type Ball Check:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**NIBCO INC.**]
g. [**Spears Manufacturing Company**]
h. [**Thermoplastic Valves, Inc**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 check valve schedule articles.
3. Body Material: PVC.
4. Body Design: Union-type ball check.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, [**socket**][**socket or threaded**][**threaded**][**flange**].
7. Ball: PVC.
8. Seals: EPDM- or FKM-rubber O-rings.

2.8 CHECK VALVES, GENERAL PURPOSE

A. Check Valves, Lift Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Jenkins Valves; a Crane Co. brand**]
    g. [**Jomar Valve**]
    h. [**Keckley Company**]
    i. [**Metraflex Company (The)**]
    j. [**Milwaukee Valve Company**]
    k. [**NIBCO INC.**]
    l. [**Stockham; a Crane Co. brand**]
    m. [**Val-Matic Valve & Manufacturing Corp.**]
    n. [**Victaulic Company**]
    o. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Vertical flow.
5. Body Material: ASTM B61 or ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: Bronze.

B. Check Valves, Lift Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**Jenkins Valves; a Crane Co. brand**]
    c. [**Jomar Valve**]
    d. [**Keckley Company**]
    e. [**Lance Valves**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]
    h. [**Red-White Valve Corp.**]
    i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**Val-Matic Valve & Manufacturing Corp.**]
    l. [**Victaulic Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Vertical flow.
5. Body Material: ASTM B61 or ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: NBR or PTFE.

C. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**Val-Matic Valve & Manufacturing Corp.**]
    m. [**Victaulic Company**]

2. Standard: MSS SP-80, Type 3.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: Bronze.

D. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 4.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: PTFE.

E. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Powell Valves**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 3.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: Bronze.

F. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Jenkins Valves; a Crane Co. brand**]
c. [**Jomar Valve**]
d. [**Lance Valves**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 4.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: PTFE.

G. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**Cooper Valves**]
e. [**Crane Fluid Systems; Crane Co.**]
f. [**DeZURIK**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**GA Industries, Inc**]
i. [**Hammond Valve**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Milwaukee Valve Company**]
p. [**Powell Valves**]
q. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.

H. Check Valves, Swing Type, Flanged Ends - Iron, with Nonmetallic-to-Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Valves**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**DeZURIK**]
d. [**Kennedy Valve Company; a division of McWane, Inc.**]
e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
h. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Composition.
9. Seat Ring: Bronze.
10. Disc Holder: Bronze.
11. Disc: PTFE.
12. Gasket: Asbestos free.

I. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Cooper Valves**]
    c. [**Crane Fluid Systems; Crane Co.**]
    d. [**Crispin Valve**]
    e. [**DeZURIK**]
    f. [**FNW; Ferguson Enterprises, Inc.**]
    g. [**GA Industries, Inc**]
    h. [**Hammond Valve**]
    i. [**Jenkins Valves; a Crane Co. brand**]
    j. [**KITZ Corporation**]
    k. [**Lance Valves**]
    l. [**Milwaukee Valve Company**]
    m. [**Powell Valves**]
    n. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.

J. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Spring-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crispin Valve**]
    e. [**DeZURIK**]
    f. [**GA Industries, Inc**]
    g. [**Kennedy Valve Company; a division of McWane, Inc.**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.
10. Closure Control: Factory-installed, exterior lever and spring.

K. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Weight-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crispin Valve**]
    e. [**DeZURIK**]
    f. [**GA Industries, Inc**]
    g. [**Kennedy Valve Company; a division of McWane, Inc.**]
    h. [**Milwaukee Valve Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.
10. Closure Control: Factory-installed, exterior lever and weight.

L. Check Valves, Swing Type, Grooved Ends - Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**DeZURIK**]
    c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    d. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
    e. [**Victaulic Company**]

2. CWP Rating: **300 psig (2070 kPa)**.
3. Body Material: ASTM A536, ductile iron.
4. Seat: NBR.
5. Disc: Spring operated, ductile iron or stainless steel.

M. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Anvil; an ASC Engineered Solution**]
    c. [**DeZURIK**]

d. [**Flomatic Valves; Flomatic Corporation**]
e. [**Jomar Valve**]
f. [**Keckley Company**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Metraflex Company (The)**]
j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
k. [**Stockham; a Crane Co. brand**]
l. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: Bronze.

N. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**DeZURIK**]
d. [**Jomar Valve**]
e. [**Keckley Company**]
f. [**Lance Valves**]
g. [**Legend Valve & Fitting, Inc**]
h. [**Metraflex Company (The)**]
i. [**Stockham; a Crane Co. brand**]
j. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: Bronze.

O. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: Bronze.

P. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Anvil; an ASC Engineered Solution**]
    c. [**Keckley Company**]
    d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    e. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: Bronze.

Q. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GA Industries, Inc**]
    b. [**Jomar Valve**]
    c. [**Keckley Company**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Wafer, single spring-loaded plate.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

R. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Flomatic Valves; Flomatic Corporation**]
    b. [**Keckley Company**]
    c. [**Stockham; a Crane Co. brand**]

d. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

S. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DeZURIK**]
   b. [**Keckley Company**]
   c. [**Stockham; a Crane Co. brand**]
   d. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: NBR.

T. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]
   d. [**Victaulic Company**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Design: Wafer, single spring-loaded plate.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

U. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jomar Valve**]
   b. [**Keckley Company**]

c. [**Stockham; a Crane Co. brand**]
d. [**Sure Flow Equipment Inc**]
e. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

V. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Keckley Company**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: NBR.

2.9 GATE VALVES, LEAD FREE

A. Gate Valves, Lead Free, Threaded or Soldered Ends - Bronze, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: Bronze with integral seat and screw-in bonnet.
5. Ends: Threaded or solder joint. See Part 3 gate valve schedule articles.

6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

B. Gate Valves, Lead Free, Threaded or Soldered Ends - Bronze, RS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**Jenkins Valves; a Crane Co. brand**]
    e. [**KITZ Corporation**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]
    h. [**Powell Valves**]
    i. [**Stockham; a Crane Co. brand**]
    j. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: Bronze with integral seat and screw-in bonnet.
5. Ends: Threaded or solder joint. See Part 3 gate valve schedule articles.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron, bronze, or aluminum.

C. Gate Valves, Lead Free, Threaded Ends - Bronze, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Crane Fluid Systems; Crane Co.**]
    d. [**Jenkins Valves; a Crane Co. brand**]
    e. [**KITZ Corporation**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**Powell Valves**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: Bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.

7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

D. Gate Valves, Lead Free, Threaded Ends - Bronze, RS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**Jenkins Valves; a Crane Co. brand**]
    e. [**KITZ Corporation**]
    f. [**Milwaukee Valve Company**]
    g. [**Powell Valves**]
    h. [**Stockham; a Crane Co. brand**]
    i. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: Bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

E. Gate Valves, Lead Free, Press Ends - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
    c. [**Hammond Valve**]
    d. [**Milwaukee Valve Company**]
    e. [**NIBCO INC.**]

2. Standards: MSS SP-80 and MSS SP-139.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Material: Bronze with integral seat and union-ring bonnet.
5. Ends: Press.
6. Press Ends Connection Rating: Minimum **200 psig (1380 kPa)**.
7. Stem: Brass or bronze, RS or NRS. See Part 3 gate valve schedule articles.
8. Disc: Solid wedge, bronze.
9. Packing: Graphite.
10. Port: Full.
11. Handwheel: Malleable iron, bronze, or aluminum.

F. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Jenkins Valves; a Crane Co. brand**]
    g. [**Jomar Valve**]
    h. [**Kennedy Valve Company; a division of McWane, Inc.**]
    i. [**KITZ Corporation**]
    j. [**Lance Valves**]
    k. [**Powell Valves**]
    l. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

G. Gate Valves, Lead Free, Flanged Ends - Iron, OS&Y, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**Jomar Valve**]
    e. [**Kennedy Valve Company; a division of McWane, Inc.**]
    f. [**KITZ Corporation**]
    g. [**Lance Valves**]
    h. [**Milwaukee Valve Company**]
    i. [**Powell Valves**]
    j. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
    k. [**WATTS; A Watts Water Technologies Company**]
    l. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flange.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

H. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Jenkins Valves; a Crane Co. brand**]
    g. [**KITZ Corporation**]
    h. [**Victaulic Company**]
    i. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flange.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

I. Gate Valves, Lead Free, Flanged Ends - Iron, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**KITZ Corporation**]
    e. [**Milwaukee Valve Company**]
    f. [**Powell Valves**]
    g. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
    h. [**Victaulic Company**]
    i. [**WATTS; A Watts Water Technologies Company**]
    j. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

J. Gate Valves - CPVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 gate valve schedule articles.
3. Body Material: CPVC.
4. Body Design: NRS.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded. See Part 3 gate valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket, socket or threaded, threaded, flanged. See Part 3 gate valve schedule articles.
7. Gate and Stem: Plastic.
8. Seals: EPDM rubber.
9. Handle: Wheel.

K. Gate Valves - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 gate valve schedule articles.
3. Body Material: PVC.
4. Body Design: NRS.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded. See Part 3 gate valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket, socket or threaded, threaded, or flanged.
7. Gate and Stem: Plastic.
8. Seals: EPDM rubber.
9. Handle: Wheel.

2.10 GATE VALVES, GENERAL PURPOSE

A. Gate Valves, Threaded or Soldered Ends - Bronze, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]

f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
5. Ends: Threaded or soldered joint. See Part 3 gate valve schedule articles.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

B. Gate Valves, Threaded or Soldered Ends - Bronze, RS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
5. Ends: Threaded or soldered joint. See Part 3 gate valve schedule articles.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron, bronze, or aluminum.

C. Gate Valves, Threaded Ends - Bronze, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]

e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

D. Gate Valves, Threaded Ends - Bronze, RS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Stockham; a Crane Co. brand**]
i. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

E. Gate Valves, Flanged Ends - Iron, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
c. [**Cooper Valves**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**FNW; Ferguson Enterprises, Inc.**]

g. [**Jenkins Valves; a Crane Co. brand**]
h. [**Jomar Valve**]
i. [**Kennedy Valve Company; a division of McWane, Inc.**]
j. [**KITZ Corporation**]
k. [**Lance Valves**]
l. [**Legend Valve & Fitting, Inc**]
m. [**Powell Valves**]
n. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Disc: Solid wedge.
9. Packing and Gasket: Asbestos free.

F. Gate Valves, Flanged Ends - Iron, OS&Y, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jomar Valve**]
f. [**Kennedy Valve Company; a division of McWane, Inc.**]
g. [**KITZ Corporation**]
h. [**Lance Valves**]
i. [**Legend Valve & Fitting, Inc**]
j. [**Milwaukee Valve Company**]
k. [**Powell Valves**]
l. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
m. [**WATTS; A Watts Water Technologies Company**]
n. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Disc: Solid wedge.
9. Packing and Gasket: Asbestos free.

G. Gate Valves, Flanged Ends - Iron, NRS, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
c. [**Cooper Valves**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**FNW; Ferguson Enterprises, Inc.**]
g. [**Jenkins Valves; a Crane Co. brand**]
h. [**KITZ Corporation**]
i. [**Victaulic Company**]
j. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Disc: Solid wedge.
9. Packing and Gasket: Asbestos free.

H. Gate Valves, Flanged Ends - Iron, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]
j. [**WATTS; A Watts Water Technologies Company**]
k. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Disc: Solid wedge.
9. Packing and Gasket: Asbestos free.

2.11 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Babbitt Steam Specialty Co**]
2. [**Roto Hammer Industries; Rotork**]
3. [**Trumbull Industries**]

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain[and attachment brackets for mounting chainwheels directly to handwheels].

1. Sprocket Rim with Chain Guides: [**Ductile iron**][**Ductile or cast iron**][**Cast iron**][**Aluminum**][**Bronze**], of type and size required for valve.[**Include zinc or epoxy coating.**]
2. Chain: [**Hot-dip, galvanized steel**][**Brass**][**Stainless steel**], of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly pressed.

F. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Chainwheels: Install chainwheels on manual operators for [**butterfly**][**globe**][**and**][**gate**] valves [**NPS 4 (DN 100)**] and larger and more than [**96 inches (2400 mm)**] above floor. Extend chains to [**60 inches (1520 mm)**] above finished floor.

I. Install check valves for proper direction of flow and as follows:

1. Check Valves: [**Center-guided type**][**and**][**plate type**], in horizontal or vertical position, between flanges.
2. Check Valves, Swing Type: In horizontal position with hinge pin level.
3. Check Valves, Lift Type: With stem upright and plumb.

J. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

K. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's written recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Stainless Steel Piping, NPS 2 (DN 50) and Smaller: [**Threaded**][**Press**] ends.
8. For Stainless Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends.
9. For Grooved-End Copper Tubing: Valve ends may be grooved.
10. For Grooved-End Steel Piping: Valve ends may be grooved.
11. Wafer-Type Valves: Flanged connections.

3.5 LOW-PRESSURE, COMPRESSED-AIR BALL VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
2. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.

3. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
5. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.
6. Ball valves, threaded ends - bronze, two piece, safety exhaust; [**200 psig (1380 kPa)**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.

3.6 HIGH-PRESSURE, COMPRESSED-AIR BALL VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
2. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
3. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
5. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.
6. Ball valves, threaded ends - bronze, two piece, safety exhaust; [**200 psig (1380 kPa)**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.

3.7 DOMESTIC HOT- AND COLD-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, lead free, threaded ends - brass, one piece.
2. Ball valves, lead free, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
3. Ball valves, lead free, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
4. Ball valves, lead free, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
5. Ball valves, lead free, threaded or soldered ends - brass, two piece with regular port and stainless

steel trim; [**threaded**][**soldered**] ends.

6. Ball valves, lead free, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
7. Ball valves, lead free, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
8. Ball valves, lead free, threaded ends - bronze, one piece with bronze trim.
9. Ball valves, lead free, threaded ends - bronze, one piece with stainless steel trim.
10. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
11. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
12. Ball valves, lead free, threaded ends - bronze, two piece with regular port and bronze or brass trim.
13. Ball valves, lead free, threaded ends - bronze, two piece with regular port and stainless steel trim.
14. Ball valves, lead free, threaded ends - bronze, three piece with full port and bronze or brass trim.
15. Ball valves, lead free, threaded ends - bronze, three piece with full port and stainless steel trim.
16. Ball valves, lead free, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**][**soldered**] ends.
17. Ball valves, lead free, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.
18. Ball valves, lead free, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.
19. Ball valves, lead free, press ends - brass, two piece with full port and brass trim.
20. Ball valves, lead free, press ends - brass, two piece with full port and stainless steel trim.
21. Ball valves, lead free, press ends - bronze, two piece with full port and bronze or brass trim.
22. Ball valves, lead free, press ends - stainless steel, two piece with full port.
23. Ball valves, lead free, flanged or threaded ends - steel, with full port, Class 150; [**threaded**][**flanged**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, lead free, flanged or threaded ends - iron, Class 125; [**flanged**][**threaded**] ends.
2. Ball valves, lead free, flanged or threaded ends - steel, with full port, Class 150; [**flanged**][**threaded**] ends.
3. Ball valves, lead free, flanged or threaded ends - steel, with regular port, Class 150; [**flanged**][**threaded**] ends.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.

C. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**] at [**73 deg F (23 deg C)**].

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: [Socket][threaded].
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

D. For PVC Pipe:

1. PVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**] at [**73 deg F (23 deg C)**].

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: [Socket][threaded].
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.8 LOW-PRESSURE, COMPRESSED-AIR BUTTERFLY VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, NBR seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP, NBR seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, NBR seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, NBR seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc; [**150**][**200**] CWP, NBR seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP, NBR seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP; NBR seat.
8. Butterfly valves, grooved end - ductile iron, 300 CWP; NBR seat.
9. Butterfly valves, grooved end - stainless steel; NBR seat.

3.9 HIGH-PRESSURE, COMPRESSED-AIR BUTTERFLY VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; 200 CWP, NBR seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; 200 CWP, NBR seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; 200 CWP, NBR seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; 200 CWP, NBR seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc; 200 CWP, NBR seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; 200 CWP, NBR seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP; NBR seat.
8. Butterfly valves, grooved end - ductile iron, 300 CWP; NBR seat.
9. Butterfly valves, grooved end - stainless steel; NBR seat.

3.10 DOMESTIC HOT- AND COLD-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, lead free, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
2. Butterfly valves, lead free, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
3. Butterfly valves, lead free, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
4. Butterfly valves, lead free, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
5. Butterfly valves, lead free, flangeless (wafer type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
6. Butterfly valves, lead free, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
7. Butterfly valves, lead free, grooved end - ductile iron, 175 CWP; [**EPDM**][**NBR**] seat.
8. Butterfly valves, lead free, grooved end - ductile iron, 300 CWP; [**EPDM**][**NBR**] seat.

B. For CPVC Pipe: CPVC butterfly valve for [**NPS 2-1/2 (DN 65)**][**NPS 5 (DN 125)**] and larger.

C. For PVC Pipe: PVC butterfly valve for [**NPS 2-1/2 (DN 65)**][**NPS 5 (DN 125)**] and larger.

D. For Stainless Steel Pipe: Stainless steel, grooved-end butterfly valve for **NPS 2-1/2 (DN 65)** and larger.

3.11 LOW-PRESSURE, COMPRESSED-AIR CHECK VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Vertical, Upflow Applications Only:

   a. Check valves, lift type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.
   b. Check valves, lift type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.

2. Horizontal and Vertical Applications:

   a. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.
   b. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.
   c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**][**soldered**] ends.
   d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, grooved ends - iron, 300 CWP.
5. Check valves, dual-plate type - iron, with metal seat, Class 125.
6. Check valves, dual-plate type - iron, with metal seat, Class 150.
7. Check valves, dual-plate type - iron, with metal seat, Class 250.
8. Check valves, dual-plate type - iron, with metal seat, Class 300.
9. Check valves, dual-plate type - iron, with resilient seat, Class 125.
10. Check valves, dual-plate type - iron, with resilient seat, Class 150.
11. Check valves, dual-plate type - iron, with resilient seat, Class 250.
12. Check valves, dual-plate type - iron, with resilient seat, Class 300.
13. Check valves, single-plate type - iron, with resilient seat, Class 125; NBR seat.
14. Check valves, single-plate type - iron, with resilient seat, Class 250; NBR seat.

3.12 HIGH-PRESSURE, COMPRESSED-AIR CHECK VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Vertical, Upflow Applications Only:

   a. Check valves, lift type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.

b. Check valves, lift type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.

2. Horizontal and Vertical Applications:

a. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.
b. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**][**soldered**] ends.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, grooved ends - iron, 300 CWP.
5. Check valves, dual-plate type - iron, with metal seat, Class 125.
6. Check valves, dual-plate type - iron, with metal seat, Class 150.
7. Check valves, dual-plate type - iron, with metal seat, Class 250.
8. Check valves, dual-plate type - iron, with metal seat, Class 300.
9. Check valves, dual-plate type - iron, with resilient seat, Class 125.
10. Check valves, dual-plate type - iron, with resilient seat, Class 150.
11. Check valves, dual-plate type - iron, with resilient seat, Class 250.
12. Check valves, dual-plate type - iron, with resilient seat, Class 300.
13. Check valves, single-plate type - iron, with resilient seat, Class 125; NBR seat.
14. Check valves, single-plate type - iron, with resilient seat, Class 250; NBR seat.

3.13 DOMESTIC HOT- AND COLD-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.
2. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.
3. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**][**soldered**] ends.
4. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**][**soldered**] ends.
5. Check valves, lead free, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, lead free, swing type, flanged or threaded ends - iron, with metal seats, Class 125; [**flanged**][**threaded**] ends.
2. Check valves, lead free, swing type, flanged or threaded ends - iron, with nonmetallic-to-metal Seats, Class 125; [**flanged**][**threaded**] ends.
3. Check valves, lead free, swing type, flanged or threaded ends - iron, with metal seats, Class 250; [**flanged**][**threaded**] ends.
4. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and spring-

closure control, Class 125; [**flanged**][**threaded**] ends.
5. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and weight-closure control, Class 125; [**flanged**][**threaded**] ends.
6. Check valves, lead free, swing type, grooved ends - iron, 300 CWP.
7. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 125.
8. Check valves, lead free, center guided - iron, globe, with metal seat, Class 125.
9. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 150.
10. Check valves, lead free, center guided - iron, globe, with metal seat, Class 150.
11. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 250.
12. Check valves, lead free, center guided - iron, globe, with metal seat, Class 250.
13. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 300.
14. Check valves, lead free, center guided - iron, globe, with metal seat, Class 300.
15. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 125; [EPDM][NBR] seat.
16. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 125; [EPDM][NBR] seat.
17. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 150; [EPDM][NBR] seat.
18. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 150; [EPDM][NBR] seat.
19. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 250; [EPDM][NBR] seat.
20. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 250; [EPDM][NBR] seat.
21. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 300; [EPDM][NBR] seat.
22. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 300; [EPDM][NBR] seat.
23. Check valves, lead free, dual-plate type - iron, with metal seat, Class 125.
24. Check valves, lead free, dual-plate type - iron, with metal seat, Class 150.
25. Check valves, lead free, dual-plate type - iron, with metal seat, Class 250.
26. Check valves, lead free, dual-plate type - iron, with metal seat, Class 300.
27. Check valves, lead free, single-plate type - iron, with resilient seat, Class 125; [EPDM][NBR] seat.
28. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 125; [EPDM][NBR] seat.
29. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 150; [EPDM][NBR] seat.
30. Check valves, lead free, single-plate type - iron, with resilient seat, Class 250; [EPDM][NBR] seat.
31. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 250; [EPDM][NBR] seat.
32. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 300; [EPDM][NBR] seat.

C. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**][**Non-union**] ball valve.
2. NPS 4 (DN 100) and Smaller: [**Union**][**Non-union**] ball valve.

D. For PVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**][**Non-union**] ball valve.
2. NPS 4 (DN 100) and Smaller: [**Union**][**Non-union**] ball valve.

3.14 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.

2. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.
3. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**][**soldered**] ends.
4. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger for Domestic Water Pumps:

1. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and spring-closure control, Class 125; [**flanged**][**threaded**] ends.
2. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and weight-closure control, Class 125; [**flanged**][**threaded**] ends.
3. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 125.
4. Check valves, lead free, center guided - iron, globe, with metal seat, Class 125.
5. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 150.
6. Check valves, lead free, center guided - iron, globe, with metal seat, Class 150.
7. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 250.
8. Check valves, lead free, center guided - iron, globe, with metal seat, Class 250.
9. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 300.
10. Check valves, lead free, center guided - iron, globe, with metal seat, Class 300.
11. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 125; [EPDM][NBR] seat.
12. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 125; [EPDM][NBR] seat.
13. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 150; [EPDM][NBR] seat.
14. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 150; [EPDM][NBR] seat.
15. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 250; [EPDM][NBR] seat.
16. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 250; [EPDM][NBR] seat.
17. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 300; [EPDM][NBR] seat.
18. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 300; [EPDM][NBR] seat.

C. Pipe NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage:

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.15 LOW-PRESSURE, COMPRESSED-AIR GATE VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**][**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**][**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.16 HIGH-PRESSURE, COMPRESSED-AIR GATE VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [threaded][soldered] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [threaded][soldered] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.17 DOMESTIC HOT- AND COLD-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, lead free, threaded or soldered ends - bronze, NRS, Class 125; [threaded][soldered] ends.
2. Gate valves, lead free, threaded or soldered ends - bronze, RS, Class 125; [threaded][soldered] ends.
3. Gate valves, lead free, threaded ends - bronze, NRS, Class 150.
4. Gate valves, lead free, threaded ends - bronze, RS, Class 150.
5. Gate valves, lead free, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, lead free, flanged ends - iron, NRS, Class 125.
2. Gate valves, lead free, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, lead free, flanged ends - iron, NRS, Class 250.
4. Gate valves, lead free, flanged ends - iron, OS&Y, Class 250.

C. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**][**Non-union**] gate valve.
2. NPS 4 (DN 100) and Smaller: [**Union**][**Non-union**] gate valve.

D. For PVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**][**Non-union**] gate valve.
2. NPS 4 (DN 100) and Smaller: [**Union**][**Non-union**] gate valve.

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SECTION 22 05 23 00A - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Angle valves.
2. Globe valves.
3. Ball valves.
4. Butterfly valves.
5. Check valves.
6. Gate valves.
7. Plug valves.
8. Chainwheels.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene-propylene-diene monomer.

C. FKM: Fluoroelastomer.

D. NBR: Nitrile butadiene rubber (also known as "Buna-N").

E. NRS: Nonrising stem.

F. OS&Y: Outside screw and yoke.

G. PTFE: Polytetrafluoroethylene.

H. RPTFE: Reinforced polytetrafluoroethylene.

I. RS: Rising stem.

J. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions and dimensions of individual components.
2. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.
6. Set gate valves closed to prevent rattling.
7. Set plug valves to open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.
6. ASME B16.22 for wrought copper and copper-alloy solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.1 for power piping valves.
10. ASME B31.9 for building services piping valves.

B. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

G. Wrench: Furnish Owner with one wrench for every [**five**][**10**]<**Insert number**> plug valves, for each size square plug-valve head.

H. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves [**NPS 4 (DN 100)**]<**Insert pipe size**> and larger.
2. Hand Lever: For quarter-turn ball valves smaller than [**NPS 4 (DN 100)**]<**Insert pipe size**>.

I. Valves in Insulated Piping:

1. Provide **2-inch (50-mm)** extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 ANGLE VALVES

A. Angle Valves, Threaded Ends - Bronze, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: PTFE.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

B. Angle Valves, Threaded Ends - Bronze, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**KITZ Corporation**]
    c. [**Milwaukee Valve Company**]
    d. [**Stockham; a Crane Co. brand**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**KITZ Corporation**]
    c. [**Milwaukee Valve Company**]
    d. [**Stockham; a Crane Co. brand**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: PTFE or stainless steel. See Part 3 angle valve schedule articles.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

2.4 GLOBE VALVES

A. Globe Valves, Threaded or Soldered Ends - Bronze, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**FNW; Ferguson Enterprises, Inc.**]
    d. [**Hammond Valve**]
    e. [**KITZ Corporation**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]
    h. [**Powell Valves**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**WATTS; A Watts Water Technologies Company**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**FNW; Ferguson Enterprises, Inc.**]
    d. [**Hammond Valve**]
    e. [**KITZ Corporation**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]
    h. [**Powell Valves**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**WATTS; A Watts Water Technologies Company**]
    l. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
6. Ends: Threaded or soldered. See Part 3 globe valve schedule articles.
7. Stem: Bronze.
8. Disc: PTFE.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

B. Globe Valves, Threaded Ends - Bronze, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**KITZ Corporation**]
    e. [**Milwaukee Valve Company**]
    f. [**NIBCO INC.**]
    g. [**Powell Valves**]
    h. [**Red-White Valve Corp.**]
    i. [**Siemens Industry, Inc., Building Technologies Division**]
    j. [**Valve Solutions, Inc.**]
    k. [**WATTS; A Watts Water Technologies Company**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**KITZ Corporation**]
    e. [**Milwaukee Valve Company**]
    f. [**NIBCO INC.**]

g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**Siemens Industry, Inc., Building Technologies Division**]
j. [**Valve Solutions, Inc.**]
k. [**WATTS; A Watts Water Technologies Company**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 2.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: PTFE or stainless steel. See Part 3 globe valve schedule articles.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

C. Globe Valves, Flanged Ends - Iron, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**KITZ Corporation**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Powell Valves**]
j. [**Red-White Valve Corp.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. [**Stockham; a Crane Co. brand**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**KITZ Corporation**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Powell Valves**]
j. [**Red-White Valve Corp.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. [**Stockham; a Crane Co. brand**]
m. <**Insert manufacturer's name**>

3. Standard: MSS SP-85, Type I.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Packing and Gasket: Asbestos free.
9. Operator: Handwheel or chainwheel.

D. Globe Valves, Flanged Ends - Iron, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**Jenkins Valves; a Crane Co. brand**]
    e. [**Milwaukee Valve Company**]
    f. [**NIBCO INC.**]
    g. [**Siemens Industry, Inc., Building Technologies Division**]
    h. [**Stockham; a Crane Co. brand**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**Jenkins Valves; a Crane Co. brand**]
    e. [**Milwaukee Valve Company**]
    f. [**NIBCO INC.**]
    g. [**Siemens Industry, Inc., Building Technologies Division**]
    h. [**Stockham; a Crane Co. brand**]
    i. <**Insert manufacturer's name**>

3. Standard: MSS SP-85, Type I.
4. CWP Rating: **500 psig (3450 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Packing and Gasket: Asbestos free.
9. Operator: Handwheel or chainwheel.

2.5 BALL VALVES

A. Ball Valves, Threaded Ends - Brass, One Piece:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**KITZ Corporation**]
b. [**WATTS; A Watts Water Technologies Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**KITZ Corporation**]
b. [**WATTS; A Watts Water Technologies Company**]
c. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. CWP Rating: **400 psig (2760 kPa)**.
5. Body Design: One piece.
6. Body Material: Forged brass.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Reduced.

B. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Bray International, Inc.**]
e. [**Center Line; a Crane Co. brand**]
f. [**DynaQuip Controls**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jenkins Valves; a Crane Co. brand**]
j. [**Jomar Valve**]
k. [**KITZ Corporation**]
l. [**Lance Valves**]
m. [**Legend Valve & Fitting, Inc**]
n. [**Marwin Valve; Richards Industries**]
o. [**Milwaukee Valve Company**]
p. [**Red-White Valve Corp.**]
q. [**Siemens Industry, Inc., Building Technologies Division**]
r. [**Stockham; a Crane Co. brand**]
s. [**Viega LLC**]
t. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]

b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Bray International, Inc.**]
e. [**Center Line; a Crane Co. brand**]
f. [**DynaQuip Controls**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jenkins Valves; a Crane Co. brand**]
j. [**Jomar Valve**]
k. [**KITZ Corporation**]
l. [**Lance Valves**]
m. [**Legend Valve & Fitting, Inc**]
n. [**Marwin Valve; Richards Industries**]
o. [**Milwaukee Valve Company**]
p. [**Red-White Valve Corp.**]
q. [**Siemens Industry, Inc., Building Technologies Division**]
r. [**Stockham; a Crane Co. brand**]
s. [**Viega LLC**]
t. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Brass.
11. Ball: Chrome-plated brass.
12. Port: Full.

C. Ball Valves, Press Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Legend Valve & Fitting, Inc**]
k. [**Milwaukee Valve Company**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Legend Valve & Fitting, Inc**]
k. [**Milwaukee Valve Company**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. <**Insert manufacturer's name**>

3. Standards: MSS SP-110 and IAPMO/ANSI Z1157.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Press.
8. Seats: PTFE or RPTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: NBR or EPDM.

D. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**DynaQuip Controls**]
f. [**Flow-Tek; a subsidiary of Bray International**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**KITZ Corporation**]
m. [**Lance Valves**]
n. [**Legend Valve & Fitting, Inc**]
o. [**Marwin Valve; Richards Industries**]
p. [**Milwaukee Valve Company**]
q. [**Red-White Valve Corp.**]
r. [**RuB Inc**]
s. [**Siemens Industry, Inc., Building Technologies Division**]
t. [**Stockham; a Crane Co. brand**]
u. [**Viega LLC**]
v. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**DynaQuip Controls**]
    f. [**Flow-Tek; a subsidiary of Bray International**]
    g. [**FNW; Ferguson Enterprises, Inc.**]
    h. [**Hammond Valve**]
    i. [**Jamesbury; a brand of Valmet**]
    j. [**Jenkins Valves; a Crane Co. brand**]
    k. [**Jomar Valve**]
    l. [**KITZ Corporation**]
    m. [**Lance Valves**]
    n. [**Legend Valve & Fitting, Inc**]
    o. [**Marwin Valve; Richards Industries**]
    p. [**Milwaukee Valve Company**]
    q. [**Red-White Valve Corp.**]
    r. [**RuB Inc**]
    s. [**Siemens Industry, Inc., Building Technologies Division**]
    t. [**Stockham; a Crane Co. brand**]
    u. [**Viega LLC**]
    v. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

E. Ball Valves, Press Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Crane Fluid Systems; Crane Co.**]
    d. [**FNW; Ferguson Enterprises, Inc.**]
    e. [**Hammond Valve**]
    f. [**Jomar Valve**]
    g. [**KITZ Corporation**]
    h. [**Lance Valves**]
    i. [**Legend Valve & Fitting, Inc**]
    j. [**Milwaukee Valve Company**]
    k. [**NIBCO INC.**]

l. [**Red-White Valve Corp.**]
m. [**RuB Inc**]
n. [**Stockham; a Crane Co. brand**]
o. [**Viega LLC**]
p. [**WATTS; A Watts Water Technologies Company**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jomar Valve**]
g. [**KITZ Corporation**]
h. [**Lance Valves**]
i. [**Legend Valve & Fitting, Inc**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Red-White Valve Corp.**]
m. [**RuB Inc**]
n. [**Stockham; a Crane Co. brand**]
o. [**Viega LLC**]
p. [**WATTS; A Watts Water Technologies Company**]
q. <**Insert manufacturer's name**>

3. Standards: MSS SP-110 and IAPMO/ANSI Z1157.
4. CWP Rating: Minimum **200 psig (1380 kPa)**.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Press.
8. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
9. Seats: PTFE or RPTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.
13. O-Ring Seal: NBR or EPDM.

F. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**FNW; Ferguson Enterprises, Inc.**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]

h. [**Jomar Valve**]
i. [**KITZ Corporation**]
j. [**Lance Valves**]
k. [**Legend Valve & Fitting, Inc**]
l. [**Marwin Valve; Richards Industries**]
m. [**Milwaukee Valve Company**]
n. [**NIBCO INC.**]
o. [**Red-White Valve Corp.**]
p. [**Siemens Industry, Inc., Building Technologies Division**]
q. [**Stockham; a Crane Co. brand**]
r. [**Viega LLC**]
s. [**WATTS; A Watts Water Technologies Company**]
t. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**FNW; Ferguson Enterprises, Inc.**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]
h. [**Jomar Valve**]
i. [**KITZ Corporation**]
j. [**Lance Valves**]
k. [**Legend Valve & Fitting, Inc**]
l. [**Marwin Valve; Richards Industries**]
m. [**Milwaukee Valve Company**]
n. [**NIBCO INC.**]
o. [**Red-White Valve Corp.**]
p. [**Siemens Industry, Inc., Building Technologies Division**]
q. [**Stockham; a Crane Co. brand**]
r. [**Viega LLC**]
s. [**WATTS; A Watts Water Technologies Company**]
t. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Brass.
11. Ball: Chrome-plated brass.
12. Port: Regular.

G. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**FNW; Ferguson Enterprises, Inc.**]
f. [**Hammond Valve**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Legend Valve & Fitting, Inc**]
k. [**Marwin Valve; Richards Industries**]
l. [**Milwaukee Valve Company**]
m. [**Red-White Valve Corp.**]
n. [**Siemens Industry, Inc., Building Technologies Division**]
o. [**Stockham; a Crane Co. brand**]
p. [**Viega LLC**]
q. [**WATTS; A Watts Water Technologies Company**]
r. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**FNW; Ferguson Enterprises, Inc.**]
f. [**Hammond Valve**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Legend Valve & Fitting, Inc**]
k. [**Marwin Valve; Richards Industries**]
l. [**Milwaukee Valve Company**]
m. [**Red-White Valve Corp.**]
n. [**Siemens Industry, Inc., Building Technologies Division**]
o. [**Stockham; a Crane Co. brand**]
p. [**Viega LLC**]
q. [**WATTS; A Watts Water Technologies Company**]
r. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Brass or bronze.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Regular.

H. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bray International, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bray International, Inc.**]
    b. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Brass.
11. Ball: Chrome-plated brass.
12. Port: Full.

I. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bray International, Inc.**]
    b. [**DynaQuip Controls**]
    c. [**Marwin Valve; Richards Industries**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bray International, Inc.**]
    b. [**DynaQuip Controls**]
    c. [**Marwin Valve; Richards Industries**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.

10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

J. Ball Valves, Threaded Ends - Bronze, One Piece with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**NIBCO INC.**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**NIBCO INC.**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. CWP Rating: **400 psig (2760 kPa)**.
5. Body Design: One piece.
6. Body Material: Bronze.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Bronze.
10. Ball: Chrome-plated brass.
11. Port: Reduced.

K. Ball Valves, Threaded Ends - Bronze, One Piece with Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**NIBCO INC.**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**NIBCO INC.**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: One piece.

6. Body Material: Bronze.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Reduced.

L. Ball Valves, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**DynaQuip Controls**]
    d. [**FNW; Ferguson Enterprises, Inc.**]
    e. [**Hammond Valve**]
    f. [**Jenkins Valves; a Crane Co. brand**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**Zurn Industries, LLC**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**DynaQuip Controls**]
    d. [**FNW; Ferguson Enterprises, Inc.**]
    e. [**Hammond Valve**]
    f. [**Jenkins Valves; a Crane Co. brand**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**Zurn Industries, LLC**]
    l. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Bronze.
11. Ball: Chrome-plated brass.
12. Port: Full.

M. Ball Valves, Press Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Center Line; a Crane Co. brand**]
    c. [**Hammond Valve**]
    d. [**Milwaukee Valve Company**]
    e. [**NIBCO INC.**]
    f. [**Red-White Valve Corp.**]
    g. [**Stockham; a Crane Co. brand**]
    h. [**Viega LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Center Line; a Crane Co. brand**]
    c. [**Hammond Valve**]
    d. [**Milwaukee Valve Company**]
    e. [**NIBCO INC.**]
    f. [**Red-White Valve Corp.**]
    g. [**Stockham; a Crane Co. brand**]
    h. [**Viega LLC**]
    i. <**Insert manufacturer's name**>

3. Standards: MSS SP-110 and IAPMO/ANSI Z1157.
4. CWP Rating: Minimum **200 psig (1380 kPa)**.
5. Body Design: Two piece.
6. Body Material: Bronze.
7. Ends: Press.
8. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
9. Seats: PTFE or RPTFE.
10. Stem: Bronze or brass.
11. Ball: Chrome-plated brass.
12. Port: Full.
13. O-Ring Seal: EPDM or NBR.

N. Ball Valves, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**DynaQuip Controls**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]

h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. [**Viega LLC**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**DynaQuip Controls**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. [**Viega LLC**]
k. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

O. Ball Valves, Threaded Ends - Bronze, Two Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DynaQuip Controls**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Red-White Valve Corp.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DynaQuip Controls**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Red-White Valve Corp.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Threaded.
9. Seats: PTFE.
10. Stem: Bronze.
11. Ball: Chrome-plated brass.
12. Port: Regular.

P. Ball Valves, Threaded Ends - Bronze, Two Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Center Line; a Crane Co. brand**]
c. [**DynaQuip Controls**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**Viega LLC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Center Line; a Crane Co. brand**]
c. [**DynaQuip Controls**]

d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**Viega LLC**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Threaded.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Regular.

Q. Ball Valves, Threaded Ends - Bronze, Three Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Bronze.
8. Ends: Threaded.
9. Seats: PTFE.
10. Stem: Bronze.
11. Ball: Chrome-plated brass.
12. Port: Full.

R. Ball Valves, Threaded Ends - Bronze, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**NIBCO INC.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**NIBCO INC.**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Bronze.
8. Ends: Threaded.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

S. Ball Valves, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

3. Standards: MSS SP-110 and MSS SP-145.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Three piece.
6. Body Material: Bronze.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Bronze.
10. Ball: Chrome-plated brass.

11. Port: Regular.

T. Ball Valves, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Bronze.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Regular.

U. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Bray International, Inc.**]
c. [**DynaQuip Controls**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jamesbury; a brand of Valmet**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Max-Air Technology Inc.**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Bray International, Inc.**]
c. [**DynaQuip Controls**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jamesbury; a brand of Valmet**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Max-Air Technology Inc.**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-72.
4. CWP Rating: **285 psig (1964 kPa)**.
5. Body Design: Split body.
6. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
7. Ends: Flanged.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

V. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Bray International, Inc.**]
c. [**DynaQuip Controls**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jamesbury; a brand of Valmet**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Stockham; a Crane Co. brand**]
l. [**Viega LLC**]
m. [**WATTS; A Watts Water Technologies Company**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]

b. [**Bray International, Inc.**]
c. [**DynaQuip Controls**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jamesbury; a brand of Valmet**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Stockham; a Crane Co. brand**]
l. [**Viega LLC**]
m. [**WATTS; A Watts Water Technologies Company**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-72.
4. CWP Rating: **720 psig (4960 kPa)**.
5. Body Design: Split body.
6. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
7. Ends: Flanged.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

W. Ball Valves, Flanged Ends - Iron, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. <**Insert manufacturer's name**>

3. Standard: MSS SP-72.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Design: Split body.
6. Body Material: ASTM A126, gray iron.
7. Ends: Flanged.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel.
11. Port: Full.

X. Ball Valves, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Bray International, Inc.**]
    d. [**FNW; Ferguson Enterprises, Inc.**]
    e. [**Guardian Worldwide LLC.**]
    f. [**Hammond Valve**]
    g. [**Jomar Valve**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Bray International, Inc.**]
    d. [**FNW; Ferguson Enterprises, Inc.**]
    e. [**Guardian Worldwide LLC.**]
    f. [**Hammond Valve**]
    g. [**Jomar Valve**]
    h. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating:**150 psig (1030 kPa)**.
5. WOG Rating: **1000 psig (6895 kPa)**.
6. Body Design: Split body.
7. Body Material: Type 316 stainless steel.
8. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Type 316 stainless steel.
11. Ball: Type 316 stainless steel.
12. Port: Full.

Y. Ball Valves - CPVC, Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Asahi/America**]
    c. [**Colonial Engineering, Inc.**]
    d. [**GF Piping Systems: Georg Fischer LLC**]
    e. [**Hayward Flow Control; Hayward Industries, Inc.**]
    f. [**IPEX USA LLC**]
    g. [**Jomar Valve**]
    h. [**Red-White Valve Corp.**]

i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**GF Piping Systems: Georg Fischer LLC**]
e. [**Hayward Flow Control; Hayward Industries, Inc.**]
f. [**IPEX USA LLC**]
g. [**Jomar Valve**]
h. [**Red-White Valve Corp.**]
i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]
k. <**Insert manufacturer's name**>

3. Standard: MSS SP-122.
4. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
5. Body Material: CPVC.
6. Body Design: Union type.
7. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
8. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
9. Ball: CPVC; full port.
10. Seals: PTFE or EPDM-rubber O-rings.
11. Handle: Tee shaped.

Z. Ball Valves - CPVC, Non-Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**IPEX USA LLC**]
e. [**Jomar Valve**]
f. [**Red-White Valve Corp.**]
g. [**Spears Manufacturing Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]

d. [**IPEX USA LLC**]
e. [**Jomar Valve**]
f. [**Red-White Valve Corp.**]
g. [**Spears Manufacturing Company**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-122.
4. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
5. Body Material: CPVC.
6. Body Design: Non-union type.
7. End Connections: Socket or threaded.
8. Ball: CPVC; full or reduced port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

AA. Ball Valves - PVC, Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**GF Piping Systems: Georg Fischer LLC**]
   e. [**Hayward Flow Control; Hayward Industries, Inc.**]
   f. [**IPEX USA LLC**]
   g. [**Jomar Valve**]
   h. [**Red-White Valve Corp.**]
   i. [**Spears Manufacturing Company**]
   j. [**Thermoplastic Valves, Inc**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**GF Piping Systems: Georg Fischer LLC**]
   e. [**Hayward Flow Control; Hayward Industries, Inc.**]
   f. [**IPEX USA LLC**]
   g. [**Jomar Valve**]
   h. [**Red-White Valve Corp.**]
   i. [**Spears Manufacturing Company**]
   j. [**Thermoplastic Valves, Inc**]
   k. <**Insert manufacturer's name**>

3. Standard: MSS SP-122.
4. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
5. Body Material: PVC.

6. Body Design: Union type.
7. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
8. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable union with socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
9. Ball: PVC; full port.
10. Seals: PTFE or EPDM-rubber O-rings.
11. Handle: Tee shaped.

BB. Ball Valves - PVC, Non-Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Asahi/America**]
    c. [**Colonial Engineering, Inc.**]
    d. [**IPEX USA LLC**]
    e. [**Jomar Valve**]
    f. [**Red-White Valve Corp.**]
    g. [**Spears Manufacturing Company**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Valve, Inc**]
    b. [**Asahi/America**]
    c. [**Colonial Engineering, Inc.**]
    d. [**IPEX USA LLC**]
    e. [**Jomar Valve**]
    f. [**Red-White Valve Corp.**]
    g. [**Spears Manufacturing Company**]
    h. <**Insert manufacturer's name**>

3. Standard: MSS SP-122.
4. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
5. Body Material: PVC.
6. Body Design: Non-union type.
7. End Connections: Socket or threaded.
8. Ball: PVC; full or reduced port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

2.6 BUTTERFLY VALVES

A. Butterfly Valves, Single Flange (Lug Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]

x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Aluminum bronze.

B. Butterfly Valves, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
s. [**NIBCO INC.**]
t. [**Norriseal**]
u. [**Red-White Valve Corp.**]
v. [**Stockham; a Crane Co. brand**]
w. [**Sure Flow Equipment Inc**]
x. [**Viega LLC**]
y. [**Zurn Industries, LLC**]
z. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]

f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
s. [**NIBCO INC.**]
t. [**Norriseal**]
u. [**Red-White Valve Corp.**]
v. [**Stockham; a Crane Co. brand**]
w. [**Sure Flow Equipment Inc**]
x. [**Viega LLC**]
y. [**Zurn Industries, LLC**]
z. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Nickel-plated[**or -coated**] ductile iron.

C. Butterfly Valves, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]

q. [**Max-Air Technology Inc.**]
r. [**Milwaukee Valve Company**]
s. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
t. [**NIBCO INC.**]
u. [**Norriseal**]
v. [**Red-White Valve Corp.**]
w. [**Stockham; a Crane Co. brand**]
x. [**Sure Flow Equipment Inc**]
y. [**Viega LLC**]
z. [**Zurn Industries, LLC**]
aa. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Max-Air Technology Inc.**]
r. [**Milwaukee Valve Company**]
s. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
t. [**NIBCO INC.**]
u. [**Norriseal**]
v. [**Red-White Valve Corp.**]
w. [**Stockham; a Crane Co. brand**]
x. [**Sure Flow Equipment Inc**]
y. [**Viega LLC**]
z. [**Zurn Industries, LLC**]
aa. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Stainless steel.

D. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Bray International, Inc.**]
    d. [**Center Line; a Crane Co. brand**]
    e. [**DeZURIK**]
    f. [**DynaQuip Controls**]
    g. [**Flo Fab Inc**]
    h. [**FNW; Ferguson Enterprises, Inc.**]
    i. [**Hammond Valve**]
    j. [**Jamesbury; a brand of Valmet**]
    k. [**Jenkins Valves; a Crane Co. brand**]
    l. [**Jomar Valve**]
    m. [**Kennedy Valve Company; a division of McWane, Inc.**]
    n. [**KITZ Corporation**]
    o. [**Lance Valves**]
    p. [**Legend Valve & Fitting, Inc**]
    q. [**Milwaukee Valve Company**]
    r. [**NIBCO INC.**]
    s. [**Norriseal**]
    t. [**Red-White Valve Corp.**]
    u. [**Stockham; a Crane Co. brand**]
    v. [**Sure Flow Equipment Inc**]
    w. [**Viega LLC**]
    x. [**Zurn Industries, LLC**]
    y. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Bray International, Inc.**]
    d. [**Center Line; a Crane Co. brand**]
    e. [**DeZURIK**]
    f. [**DynaQuip Controls**]
    g. [**Flo Fab Inc**]
    h. [**FNW; Ferguson Enterprises, Inc.**]
    i. [**Hammond Valve**]
    j. [**Jamesbury; a brand of Valmet**]
    k. [**Jenkins Valves; a Crane Co. brand**]
    l. [**Jomar Valve**]
    m. [**Kennedy Valve Company; a division of McWane, Inc.**]
    n. [**KITZ Corporation**]
    o. [**Lance Valves**]
    p. [**Legend Valve & Fitting, Inc**]
    q. [**Milwaukee Valve Company**]
    r. [**NIBCO INC.**]
    s. [**Norriseal**]
    t. [**Red-White Valve Corp.**]

u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Aluminum bronze.

E. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]

d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Nickel-plated[**or -coated**] ductile iron.

F. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]

p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Stainless steel.

G. Butterfly Valves, Grooved End - Ductile Iron, 175 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
j. [**Victaulic Company**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
j. [**Victaulic Company**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **175 psig (1200 kPa)**.
5. Body Material: Coated, ductile iron.
6. Ends: Grooved.
7. Stem: Two-piece stainless steel.
8. Disc: Coated, ductile iron.
9. Seat: EPDM.

H. Butterfly Valves, Grooved End - Ductile Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]

d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
j. [**Victaulic Company**]
k. [**WATTS; A Watts Water Technologies Company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
j. [**Victaulic Company**]
k. [**WATTS; A Watts Water Technologies Company**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. NPS 8 (DN 50) and Smaller CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: Coated, ductile iron
6. Ends: Grooved.
7. Stem: Two-piece stainless steel.
8. Disc: Coated, ductile iron.
9. Seat: EPDM.

I. Butterfly Valves, Single Flange (Lug Type) - High Performance, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flowseal; Crane Energy Flow Solutions**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**Stockham; a Crane Co. brand**]
k. [**XOMOX; Crane ChemPharma & Energy**]

l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flowseal; Crane Energy Flow Solutions**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**Stockham; a Crane Co. brand**]
k. [**XOMOX; Crane ChemPharma & Energy**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-68.
4. CWP Rating: **285 psig (1965 kPa)** at **100 deg F (38 deg C)**.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: Carbon or stainless steel. See Part 3 butterfly valve schedule articles.
7. Seat: Reinforced PTFE or metal.
8. Stem: Stainless steel; offset from seat plane.
9. Disc: Type 316 stainless steel.
10. Service: Bidirectional.

J. Butterfly Valves, Single Flange (Lug Type) - High Performance, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flowseal; Crane Energy Flow Solutions**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]
h. [**Milwaukee Valve Company**]
i. [**NIBCO INC.**]
j. [**Process Development & Control, Inc.**]
k. [**Stockham; a Crane Co. brand**]
l. [**XOMOX; Crane ChemPharma & Energy**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]

b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flowseal; Crane Energy Flow Solutions**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]
h. [**Milwaukee Valve Company**]
i. [**NIBCO INC.**]
j. [**Process Development & Control, Inc.**]
k. [**Stockham; a Crane Co. brand**]
l. [**XOMOX; Crane ChemPharma & Energy**]
m. <**Insert manufacturer's name**>

3. Standard: MSS SP-68.
4. CWP Rating: **720 psig (4965 kPa)** at **100 deg F (38 deg C)**.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: Carbon or stainless steel. See Part 3 butterfly valve schedule articles.
7. Seat: Reinforced PTFE or metal.
8. Stem: Stainless steel; offset from seat plane.
9. Disc: Type 316 stainless steel.
10. Service: Bidirectional.

2.7 CHECK VALVES

A. Check Valves, Lift Type, Threaded Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Keckley Company**]
i. [**Metraflex Company (The)**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Val-Matic Valve & Manufacturing Corp.**]
n. [**Victaulic Company**]
o. [**WATTS; A Watts Water Technologies Company**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]

c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Keckley Company**]
i. [**Metraflex Company (The)**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Val-Matic Valve & Manufacturing Corp.**]
n. [**Victaulic Company**]
o. [**WATTS; A Watts Water Technologies Company**]
p. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Design: Vertical flow.
6. Body Material: ASTM B61 or ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: Bronze.

B. Check Valves, Lift Type, Threaded Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Crane Fluid Systems; Crane Co.**]
   b. [**Jenkins Valves; a Crane Co. brand**]
   c. [**Jomar Valve**]
   d. [**Keckley Company**]
   e. [**Lance Valves**]
   f. [**Milwaukee Valve Company**]
   g. [**NIBCO INC.**]
   h. [**Red-White Valve Corp.**]
   i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   j. [**Stockham; a Crane Co. brand**]
   k. [**Val-Matic Valve & Manufacturing Corp.**]
   l. [**Victaulic Company**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Crane Fluid Systems; Crane Co.**]
   b. [**Jenkins Valves; a Crane Co. brand**]
   c. [**Jomar Valve**]
   d. [**Keckley Company**]
   e. [**Lance Valves**]
   f. [**Milwaukee Valve Company**]
   g. [**NIBCO INC.**]
   h. [**Red-White Valve Corp.**]

i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
j. [**Stockham; a Crane Co. brand**]
k. [**Val-Matic Valve & Manufacturing Corp.**]
l. [**Victaulic Company**]
m. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 2.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Design: Vertical flow.
6. Body Material: ASTM B61 or ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: NBR or PTFE.

C. Check Valves, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Jenkins Valves; a Crane Co. brand**]
d. [**Jomar Valve**]
e. [**Keckley Company**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Red-White Valve Corp.**]
j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
k. [**Stockham; a Crane Co. brand**]
l. [**Val-Matic Valve & Manufacturing Corp.**]
m. [**Victaulic Company**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Jenkins Valves; a Crane Co. brand**]
d. [**Jomar Valve**]
e. [**Keckley Company**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Red-White Valve Corp.**]
j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
k. [**Stockham; a Crane Co. brand**]
l. [**Val-Matic Valve & Manufacturing Corp.**]
m. [**Victaulic Company**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 3.
4. CWP Rating: **200 psig (1380 kPa)**.

5. Body Design: Horizontal flow.
6. Body Material: ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: Bronze.

D. Check Valves, Swing Type, Threaded Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]
    l. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 4.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Design: Horizontal flow.
6. Body Material: ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: PTFE.

E. Check Valves, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Powell Valves**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Powell Valves**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 3.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Design: Horizontal flow.
6. Body Material: ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: Bronze.

F. Check Valves, Swing Type, Threaded Ends - Bronze, with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Jenkins Valves; a Crane Co. brand**]
c. [**Jomar Valve**]
d. [**Lance Valves**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]

i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Jenkins Valves; a Crane Co. brand**]
c. [**Jomar Valve**]
d. [**Lance Valves**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 4.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Design: Horizontal flow.
6. Body Material: ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: PTFE.

G. Check Valves, Swing Type, Press Ends - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
d. [**Hammond Valve**]
e. [**Legend Valve & Fitting, Inc**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
d. [**Hammond Valve**]
e. [**Legend Valve & Fitting, Inc**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-80.

4. CWP Rating: Minimum **200 psig (1380 kPa)**.
5. Body Design: Horizontal flow.
6. Body Material: ASTM B584, bronze.
7. Ends: Press.
8. Press Ends Connection Rating: Minimum **200 psig (1380 kPa)**.
9. Disc: Brass or bronze.

H. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Bray International, Inc.**]
    d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    e. [**Cooper Valves**]
    f. [**Crane Fluid Systems; Crane Co.**]
    g. [**DeZURIK**]
    h. [**FNW; Ferguson Enterprises, Inc.**]
    i. [**GA Industries, Inc**]
    j. [**Hammond Valve**]
    k. [**Jenkins Valves; a Crane Co. brand**]
    l. [**Jomar Valve**]
    m. [**Kennedy Valve Company; a division of McWane, Inc.**]
    n. [**KITZ Corporation**]
    o. [**Lance Valves**]
    p. [**Milwaukee Valve Company**]
    q. [**Powell Valves**]
    r. [**Victaulic Company**]
    s. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Bray International, Inc.**]
    d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    e. [**Cooper Valves**]
    f. [**Crane Fluid Systems; Crane Co.**]
    g. [**DeZURIK**]
    h. [**FNW; Ferguson Enterprises, Inc.**]
    i. [**GA Industries, Inc**]
    j. [**Hammond Valve**]
    k. [**Jenkins Valves; a Crane Co. brand**]
    l. [**Jomar Valve**]
    m. [**Kennedy Valve Company; a division of McWane, Inc.**]
    n. [**KITZ Corporation**]
    o. [**Lance Valves**]
    p. [**Milwaukee Valve Company**]
    q. [**Powell Valves**]
    r. [**Victaulic Company**]

s. **<Insert manufacturer's name>**

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Bronze.
10. Gasket: Asbestos free.

I. Check Valves, Swing Type, Flanged Ends - Iron, with Nonmetallic-to-Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bray International, Inc.**]
   b. [**Cooper Valves**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**DeZURIK**]
   e. [**Kennedy Valve Company; a division of McWane, Inc.**]
   f. [**KITZ Corporation**]
   g. [**Lance Valves**]
   h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   i. [**Victaulic Company**]
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Bray International, Inc.**]
   b. [**Cooper Valves**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**DeZURIK**]
   e. [**Kennedy Valve Company; a division of McWane, Inc.**]
   f. [**KITZ Corporation**]
   g. [**Lance Valves**]
   h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   i. [**Victaulic Company**]
   j. **<Insert manufacturer's name>**

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Composition.
10. Seat Ring: Bronze.
11. Disc Holder: Bronze.

12. Disc: PTFE.
13. Gasket: Asbestos free.

J. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Bray International, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Crispin Valve**]
    f. [**DeZURIK**]
    g. [**FNW; Ferguson Enterprises, Inc.**]
    h. [**GA Industries, Inc**]
    i. [**Hammond Valve**]
    j. [**Jenkins Valves; a Crane Co. brand**]
    k. [**KITZ Corporation**]
    l. [**Lance Valves**]
    m. [**Milwaukee Valve Company**]
    n. [**Powell Valves**]
    o. [**Victaulic Company**]
    p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Bray International, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Crispin Valve**]
    f. [**DeZURIK**]
    g. [**FNW; Ferguson Enterprises, Inc.**]
    h. [**GA Industries, Inc**]
    i. [**Hammond Valve**]
    j. [**Jenkins Valves; a Crane Co. brand**]
    k. [**KITZ Corporation**]
    l. [**Lance Valves**]
    m. [**Milwaukee Valve Company**]
    n. [**Powell Valves**]
    o. [**Victaulic Company**]
    p. <**Insert manufacturer's name**>

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Bronze.
10. Gasket: Asbestos free.

K. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Spring-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Bray International, Inc.**]
    c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    d. [**Cooper Valves**]
    e. [**Crispin Valve**]
    f. [**DeZURIK**]
    g. [**GA Industries, Inc**]
    h. [**Kennedy Valve Company; a division of McWane, Inc.**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Bray International, Inc.**]
    c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    d. [**Cooper Valves**]
    e. [**Crispin Valve**]
    f. [**DeZURIK**]
    g. [**GA Industries, Inc**]
    h. [**Kennedy Valve Company; a division of McWane, Inc.**]
    i. <**Insert manufacturer's name**>

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Bronze.
10. Gasket: Asbestos free.
11. Closure Control: Factory-installed, exterior lever and spring.

L. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Weight-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**ASC Engineered Solutions**]
    c. [**Bray International, Inc.**]
    d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    e. [**Cooper Valves**]
    f. [**Crispin Valve**]
    g. [**DeZURIK**]

h. [**GA Industries, Inc**]
i. [**Kennedy Valve Company; a division of McWane, Inc.**]
j. [**Milwaukee Valve Company**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
e. [**Cooper Valves**]
f. [**Crispin Valve**]
g. [**DeZURIK**]
h. [**GA Industries, Inc**]
i. [**Kennedy Valve Company; a division of McWane, Inc.**]
j. [**Milwaukee Valve Company**]
k. <**Insert manufacturer's name**>

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Bronze.
10. Gasket: Asbestos free.
11. Closure Control: Factory-installed, exterior lever and weight.

M. Check Valves, Swing Type, Grooved End - Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**DeZURIK**]
e. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
f. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
g. [**Victaulic Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**DeZURIK**]

e. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
f. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
g. [**Victaulic Company**]
h. <**Insert manufacturer's name**>

3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A536, ductile iron.
5. Seat: EPDM.
6. Disc: Spring operated, ductile iron or stainless steel.

N. Check Valves, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Milwaukee Valve Company**]
m. [**Val-Matic Valve & Manufacturing Corp.**]
n. [**Victaulic Company**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Milwaukee Valve Company**]
m. [**Val-Matic Valve & Manufacturing Corp.**]
n. [**Victaulic Company**]
o. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.

4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Compact wafer.
8. Seat: Bronze.

O. Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ASC Engineered Solutions**]
    b. [**Crispin Valve**]
    c. [**DFT Inc.**]
    d. [**Flomatic Valves; Flomatic Corporation**]
    e. [**GA Industries, Inc**]
    f. [**KITZ Corporation**]
    g. [**Metraflex Company (The)**]
    h. [**Milwaukee Valve Company**]
    i. [**Val-Matic Valve & Manufacturing Corp.**]
    j. [**WATTS; A Watts Water Technologies Company**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ASC Engineered Solutions**]
    b. [**Crispin Valve**]
    c. [**DFT Inc.**]
    d. [**Flomatic Valves; Flomatic Corporation**]
    e. [**GA Industries, Inc**]
    f. [**KITZ Corporation**]
    g. [**Metraflex Company (The)**]
    h. [**Milwaukee Valve Company**]
    i. [**Val-Matic Valve & Manufacturing Corp.**]
    j. [**WATTS; A Watts Water Technologies Company**]
    k. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: Bronze.

P. Check Valves, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Victaulic Company**]
m. [**WATTS; A Watts Water Technologies Company**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Victaulic Company**]
m. [**WATTS; A Watts Water Technologies Company**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Compact wafer.
8. Seat: Bronze.

Q. Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**GA Industries, Inc**]
e. [**KITZ Corporation**]
f. [**Metraflex Company (The)**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crispin Valve**]
    b. [**DFT Inc.**]
    c. [**Flomatic Valves; Flomatic Corporation**]
    d. [**GA Industries, Inc**]
    e. [**KITZ Corporation**]
    f. [**Metraflex Company (The)**]
    g. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: Bronze.

R. Check Valves, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Cooper Valves**]
    c. [**DeZURIK**]
    d. [**DFT Inc.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Keckley Company**]
    g. [**Metraflex Company (The)**]
    h. [**Val-Matic Valve & Manufacturing Corp.**]
    i. [**Victaulic Company**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Cooper Valves**]
    c. [**DeZURIK**]
    d. [**DFT Inc.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Keckley Company**]
    g. [**Metraflex Company (The)**]
    h. [**Val-Matic Valve & Manufacturing Corp.**]
    i. [**Victaulic Company**]
    j. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.

6. Body Material: ASTM A126, gray iron.
7. Style: Compact wafer, spring loaded.
8. Seat: Bronze.

S. Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DFT Inc.**]
    b. [**Flomatic Valves; Flomatic Corporation**]
    c. [**Metraflex Company (The)**]
    d. [**Val-Matic Valve & Manufacturing Corp.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**DFT Inc.**]
    b. [**Flomatic Valves; Flomatic Corporation**]
    c. [**Metraflex Company (The)**]
    d. [**Val-Matic Valve & Manufacturing Corp.**]
    e. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: Bronze.

T. Check Valves, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Cooper Valves**]
    c. [**Crispin Valve**]
    d. [**DFT Inc.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Keckley Company**]
    g. [**Metraflex Company (The)**]
    h. [**Victaulic Company**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Cooper Valves**]
c. [**Crispin Valve**]
d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Keckley Company**]
g. [**Metraflex Company (The)**]
h. [**Victaulic Company**]
i. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Compact wafer, spring loaded.
8. Seat: Bronze.

U. Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: Bronze.

V. Check Valves, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cooper Valves**]
c. [**DeZURIK**]

d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Val-Matic Valve & Manufacturing Corp.**]
g. [**Victaulic Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cooper Valves**]
c. [**DeZURIK**]
d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Val-Matic Valve & Manufacturing Corp.**]
g. [**Victaulic Company**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Compact wafer.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

W. Check Valves, Center Guided - Iron, Globe, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DFT Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Val-Matic Valve & Manufacturing Corp.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**DFT Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Val-Matic Valve & Manufacturing Corp.**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

X. Check Valves, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**GA Industries, Inc**]
   f. [**Val-Matic Valve & Manufacturing Corp.**]
   g. [**Victaulic Company**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**GA Industries, Inc**]
   f. [**Val-Matic Valve & Manufacturing Corp.**]
   g. [**Victaulic Company**]
   h. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Compact wafer.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Y. Check Valves, Center Guided - Iron, Globe, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]
   d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Z. Check Valves, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cooper Valves**]
    b. [**DeZURIK**]
    c. [**DFT Inc.**]
    d. [**Flomatic Valves; Flomatic Corporation**]
    e. [**Val-Matic Valve & Manufacturing Corp.**]
    f. [**Victaulic Company**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Cooper Valves**]
    b. [**DeZURIK**]
    c. [**DFT Inc.**]
    d. [**Flomatic Valves; Flomatic Corporation**]
    e. [**Val-Matic Valve & Manufacturing Corp.**]
    f. [**Victaulic Company**]
    g. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Compact wafer, spring loaded.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

AA. Check Valves, Center Guided - Iron, Globe, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DFT Inc.**]
    b. [**Flomatic Valves; Flomatic Corporation**]
    c. [**Val-Matic Valve & Manufacturing Corp.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**DFT Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Val-Matic Valve & Manufacturing Corp.**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

BB. Check Valves, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Valves**]
b. [**DeZURIK**]
c. [**DFT Inc.**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**Victaulic Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cooper Valves**]
b. [**DeZURIK**]
c. [**DFT Inc.**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**Victaulic Company**]
f. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Compact wafer, spring loaded.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

CC. Check Valves, Center Guided - Iron, Globe, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DFT Inc.**]

b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**DFT Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

DD. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Jomar Valve**]
g. [**Keckley Company**]
h. [**Lance Valves**]
i. [**Legend Valve & Fitting, Inc**]
j. [**Metraflex Company (The)**]
k. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
l. [**Stockham; a Crane Co. brand**]
m. [**Sure Flow Equipment Inc**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Jomar Valve**]
g. [**Keckley Company**]
h. [**Lance Valves**]

i. [**Legend Valve & Fitting, Inc**]
j. [**Metraflex Company (The)**]
k. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
l. [**Stockham; a Crane Co. brand**]
m. [**Sure Flow Equipment Inc**]
n. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A126, gray iron.
8. Seat: Bronze.

EE. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Jomar Valve**]
f. [**Keckley Company**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Metraflex Company (The)**]
j. [**Stockham; a Crane Co. brand**]
k. [**Sure Flow Equipment Inc**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Jomar Valve**]
f. [**Keckley Company**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Metraflex Company (The)**]
j. [**Stockham; a Crane Co. brand**]
k. [**Sure Flow Equipment Inc**]
l. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.

8. Seat: Bronze.

FF. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Bray International, Inc.**]
   d. [**Keckley Company**]
   e. [**Stockham; a Crane Co. brand**]
   f. [**Sure Flow Equipment Inc**]
   g. [**Val-Matic Valve & Manufacturing Corp.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Bray International, Inc.**]
   d. [**Keckley Company**]
   e. [**Stockham; a Crane Co. brand**]
   f. [**Sure Flow Equipment Inc**]
   g. [**Val-Matic Valve & Manufacturing Corp.**]
   h. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A126, gray iron.
8. Seat: Bronze.

GG. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Bray International, Inc.**]
   d. [**Keckley Company**]
   e. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   f. [**Sure Flow Equipment Inc**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**Keckley Company**]
e. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
f. [**Sure Flow Equipment Inc**]
g. **<Insert manufacturer's name>**

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
8. Seat: Bronze.

HH. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]
   d. **<Insert manufacturer's name>**

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Wafer, single spring-loaded plate.
7. Body Material: ASTM A126, gray iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

II. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bray International, Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Keckley Company**]
   d. [**Stockham; a Crane Co. brand**]

e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bray International, Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A126, gray iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

JJ. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bray International, Inc.**]
b. [**DeZURIK**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bray International, Inc.**]
b. [**DeZURIK**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

KK. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GA Industries, Inc**]
    b. [**Jomar Valve**]
    c. [**Keckley Company**]
    d. [**Victaulic Company**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**GA Industries, Inc**]
    b. [**Jomar Valve**]
    c. [**Keckley Company**]
    d. [**Victaulic Company**]
    e. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Design: Wafer, single spring-loaded plate.
7. Body Material: ASTM A126, gray iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

LL. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jomar Valve**]
    b. [**Keckley Company**]
    c. [**Stockham; a Crane Co. brand**]
    d. [**Sure Flow Equipment Inc**]
    e. [**Val-Matic Valve & Manufacturing Corp.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jomar Valve**]
    b. [**Keckley Company**]
    c. [**Stockham; a Crane Co. brand**]
    d. [**Sure Flow Equipment Inc**]
    e. [**Val-Matic Valve & Manufacturing Corp.**]
    f. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.

6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A126, gray iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

MM. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Keckley Company**]
    b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    c. [**Sure Flow Equipment Inc**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Keckley Company**]
    b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    c. [**Sure Flow Equipment Inc**]
    d. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

NN. Check Valves - CPVC, Union-Type Ball Check:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Asahi/America**]
    c. [**GF Piping Systems: Georg Fischer LLC**]
    d. [**Hayward Flow Control; Hayward Industries, Inc.**]
    e. [**IPEX USA LLC**]
    f. [**Legend Valve & Fitting, Inc**]
    g. [**NIBCO INC.**]
    h. [**Spears Manufacturing Company**]
    i. [**Thermoplastic Valves, Inc**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Valve, Inc**]

b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**Legend Valve & Fitting, Inc**]
g. [**NIBCO INC.**]
h. [**Spears Manufacturing Company**]
i. [**Thermoplastic Valves, Inc**]
j. <**Insert manufacturer's name**>

3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 check valve schedule articles.
4. Body Material: CPVC.
5. Body Design: Union-type ball check.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
8. Ball: CPVC.
9. Seals: EPDM- or FKM-rubber O-rings.

OO. Check Valves - PVC, Union-Type Ball Check:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**Legend Valve & Fitting, Inc**]
g. [**NIBCO INC.**]
h. [**Spears Manufacturing Company**]
i. [**Thermoplastic Valves, Inc**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**Legend Valve & Fitting, Inc**]
g. [**NIBCO INC.**]
h. [**Spears Manufacturing Company**]
i. [**Thermoplastic Valves, Inc**]
j. <**Insert manufacturer's name**>

3. Pressure Rating and Temperature: **125 psig (860 kPa)** **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 check valve schedule articles.

4. Body Material: PVC.
5. Body Design: Union-type ball check.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
8. Ball: PVC.
9. Seals: EPDM- or FKM-rubber O-rings.

2.8 GATE VALVES

A. Gate Valves, Threaded or Soldered Ends - Bronze, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Crane Fluid Systems; Crane Co.**]
    d. [**FNW; Ferguson Enterprises, Inc.**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**KITZ Corporation**]
    g. [**Lance Valves**]
    h. [**Milwaukee Valve Company**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**WATTS; A Watts Water Technologies Company**]
    m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Valve, Inc**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Crane Fluid Systems; Crane Co.**]
    d. [**FNW; Ferguson Enterprises, Inc.**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**KITZ Corporation**]
    g. [**Lance Valves**]
    h. [**Milwaukee Valve Company**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**WATTS; A Watts Water Technologies Company**]
    m. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
6. Ends: Threaded or soldered. See Part 3 gate valve schedule articles.

7. Stem: Bronze.
8. Disc: Solid wedge; bronze.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

B. Gate Valves, Threaded or Soldered Ends - Bronze, RS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**FNW; Ferguson Enterprises, Inc.**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**KITZ Corporation**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**WATTS; A Watts Water Technologies Company**]
    m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**FNW; Ferguson Enterprises, Inc.**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**KITZ Corporation**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**WATTS; A Watts Water Technologies Company**]
    m. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 2.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
6. Ends: Threaded or soldered. See Part 3 gate valve schedule articles.
7. Stem: Bronze.
8. Disc: Solid wedge; bronze.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron, bronze, or aluminum.

C. Gate Valves, Threaded Ends - Bronze, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: Solid wedge, bronze.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

D. Gate Valves, Threaded Ends - Bronze, RS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]

f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Stockham; a Crane Co. brand**]
i. [**WATTS; A Watts Water Technologies Company**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Stockham; a Crane Co. brand**]
i. [**WATTS; A Watts Water Technologies Company**]
j. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 2.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: Solid wedge, bronze.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

E. Gate Valves, Press Ends - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
c. [**Hammond Valve**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
c. [**Hammond Valve**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. <**Insert manufacturer's name**>

3. Standard: MSS SP-80.

4. CWP Rating: Minimum **200 psig (1380 kPa)**.
5. Body Material: Bronze with integral seat and union-ring bonnet.
6. Ends: Press.
7. Press Ends Connection Rating: Minimum **200 psig (1380 kPa)**.
8. Stem: Brass or bronze RS or NRS. See Part 3 gate valve schedule articles.
9. Disc: Solid wedge, bronze.
10. Packing: Graphite.
11. Port: Full.
12. Handwheel: Malleable iron, bronze, or aluminum.

F. Gate Valves, Flanged Ends - Iron, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**FNW; Ferguson Enterprises, Inc.**]
    g. [**Jenkins Valves; a Crane Co. brand**]
    h. [**Jomar Valve**]
    i. [**Kennedy Valve Company; a division of McWane, Inc.**]
    j. [**KITZ Corporation**]
    k. [**Lance Valves**]
    l. [**Legend Valve & Fitting, Inc**]
    m. [**Powell Valves**]
    n. [**Zurn Industries, LLC**]
    o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**FNW; Ferguson Enterprises, Inc.**]
    g. [**Jenkins Valves; a Crane Co. brand**]
    h. [**Jomar Valve**]
    i. [**Kennedy Valve Company; a division of McWane, Inc.**]
    j. [**KITZ Corporation**]
    k. [**Lance Valves**]
    l. [**Legend Valve & Fitting, Inc**]
    m. [**Powell Valves**]
    n. [**Zurn Industries, LLC**]
    o. <**Insert manufacturer's name**>

3. Standard: MSS SP-70, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.

5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.

G. Gate Valves, Flanged Ends - Iron, OS&Y, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**FNW; Ferguson Enterprises, Inc.**]
    d. [**Hammond Valve**]
    e. [**Jomar Valve**]
    f. [**Kennedy Valve Company; a division of McWane, Inc.**]
    g. [**KITZ Corporation**]
    h. [**Lance Valves**]
    i. [**Legend Valve & Fitting, Inc**]
    j. [**Milwaukee Valve Company**]
    k. [**Powell Valves**]
    l. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
    m. [**WATTS; A Watts Water Technologies Company**]
    n. [**Zurn Industries, LLC**]
    o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**FNW; Ferguson Enterprises, Inc.**]
    d. [**Hammond Valve**]
    e. [**Jomar Valve**]
    f. [**Kennedy Valve Company; a division of McWane, Inc.**]
    g. [**KITZ Corporation**]
    h. [**Lance Valves**]
    i. [**Legend Valve & Fitting, Inc**]
    j. [**Milwaukee Valve Company**]
    k. [**Powell Valves**]
    l. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
    m. [**WATTS; A Watts Water Technologies Company**]
    n. [**Zurn Industries, LLC**]
    o. <**Insert manufacturer's name**>

3. Standard: MSS SP-70, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron with bolted bonnet.

7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.

H. Gate Valves, Flanged Ends - Iron, NRS, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**FNW; Ferguson Enterprises, Inc.**]
    g. [**Jenkins Valves; a Crane Co. brand**]
    h. [**KITZ Corporation**]
    i. [**Victaulic Company**]
    j. [**Zurn Industries, LLC**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**FNW; Ferguson Enterprises, Inc.**]
    g. [**Jenkins Valves; a Crane Co. brand**]
    h. [**KITZ Corporation**]
    i. [**Victaulic Company**]
    j. [**Zurn Industries, LLC**]
    k. <**Insert manufacturer's name**>

3. Standard: MSS SP-70, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.

I. Gate Valves, Flanged Ends - Iron, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]
j. [**WATTS; A Watts Water Technologies Company**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]
j. [**WATTS; A Watts Water Technologies Company**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-70, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.

J. Gate Valves - CPVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 gate valve schedule articles.
4. Body Material: CPVC.
5. Body Design: NRS.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded. See Part 3 gate valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket, socket or threaded, threaded, or flanged. See Part 3 gate valve schedule articles.
8. Gate and Stem: Plastic.
9. Seals: EPDM rubber.
10. Handle: Wheel.

K. Gate Valves - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 gate valve schedule articles.
4. Body Material: PVC.
5. Body Design: NRS.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded. See Part 3 gate valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].
8. Gate and Stem: Plastic.
9. Seals: EPDM rubber.
10. Handle: Wheel.

2.9 PLUG VALVES

A. Plug Valves, Lubricated Type, Threaded Ends - Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**DeZURIK**]
    e. [**Flowserve Corporation**]
    f. [**Homestead Valve: a division of Olson Technologies, Inc.**]
    g. [**Nordstrom; a Flowserve Corporation brand**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**DeZURIK**]
    e. [**Flowserve Corporation**]
    f. [**Homestead Valve: a division of Olson Technologies, Inc.**]
    g. [**Nordstrom; a Flowserve Corporation brand**]
    h. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type I, single gland.
4. CWP Rating, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **200 psig (1380 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

B. Plug Valves, Lubricated Type, Flanged Ends - Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crispin Valve**]
    b. [**DeZURIK**]
    c. [**Flomatic Valves; Flomatic Corporation**]
    d. [**Flowserve Corporation**]
    e. [**GA Industries, Inc**]
    f. [**Homestead Valve: a division of Olson Technologies, Inc.**]
    g. [**Kennedy Valve Company; a division of McWane, Inc.**]
    h. [**National Oilwell Varco**]
    i. [**NIBCO INC.**]
    j. [**Nordstrom; a Flowserve Corporation brand**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crispin Valve**]

b. [**DeZURIK**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**Flowserve Corporation**]
e. [**GA Industries, Inc**]
f. [**Homestead Valve: a division of Olson Technologies, Inc.**]
g. [**Kennedy Valve Company; a division of McWane, Inc.**]
h. [**National Oilwell Varco**]
i. [**NIBCO INC.**]
j. [**Nordstrom; a Flowserve Corporation brand**]
k. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type I single gland or Type II regular gland. See Part 3 plug valve schedule articles.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
7. Plug: Cast iron or bronze with sealant groove.

C. Plug Valves, Lubricated Type, Threaded Ends - Cylindrical, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flowserve Corporation**]
b. [**Homestead Valve: a division of Olson Technologies, Inc.**]
c. [**National Oilwell Varco**]
d. [**Nordstrom; a Flowserve Corporation brand**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Flowserve Corporation**]
b. [**Homestead Valve: a division of Olson Technologies, Inc.**]
c. [**National Oilwell Varco**]
d. [**Nordstrom; a Flowserve Corporation brand**]
e. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type IV.
4. CWP Rating, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **200 psig (1380 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

D. Plug Valves, Lubricated Type, Flanged Ends - Cylindrical, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flomatic Valves; Flomatic Corporation**]
b. [**Flowserve Corporation**]

c. [**Homestead Valve: a division of Olson Technologies, Inc.**]
d. [**National Oilwell Varco**]
e. [**Nordstrom; a Flowserve Corporation brand**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Flomatic Valves; Flomatic Corporation**]
b. [**Flowserve Corporation**]
c. [**Homestead Valve: a division of Olson Technologies, Inc.**]
d. [**National Oilwell Varco**]
e. [**Nordstrom; a Flowserve Corporation brand**]
f. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type IV.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

E. Plug Valves, Lubricated Type, Threaded Ends - Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DeZURIK**]
b. [**Homestead Valve: a division of Olson Technologies, Inc.**]
c. [**National Oilwell Varco**]
d. [**Nordstrom; a Flowserve Corporation brand**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**DeZURIK**]
b. [**Homestead Valve: a division of Olson Technologies, Inc.**]
c. [**National Oilwell Varco**]
d. [**Nordstrom; a Flowserve Corporation brand**]
e. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type I single gland or Type II regular gland. See Part 3 plug valve schedule articles.
4. CWP Rating, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **400 psig (2760 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

F. Plug Valves, Lubricated Type, Flanged Ends - Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DeZURIK**]
c. [**Flowserve Corporation**]
d. [**Homestead Valve: a division of Olson Technologies, Inc.**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**National Oilwell Varco**]
g. [**Nordstrom; a Flowserve Corporation brand**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**DeZURIK**]
c. [**Flowserve Corporation**]
d. [**Homestead Valve: a division of Olson Technologies, Inc.**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**National Oilwell Varco**]
g. [**Nordstrom; a Flowserve Corporation brand**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type I single gland or Type II regular gland. See Part 3 plug valve schedule articles.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
7. Plug: Cast iron or bronze with sealant groove.

G. Plug Valves, Lubricated Type, Threaded Ends - Cylindrical, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flowserve Corporation**]
b. [**National Oilwell Varco**]
c. [**Nordstrom; a Flowserve Corporation brand**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Flowserve Corporation**]
b. [**National Oilwell Varco**]
c. [**Nordstrom; a Flowserve Corporation brand**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type IV.
4. CWP Rating, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **400 psig (2760 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

H. Plug Valves, Lubricated Type, Flanged Ends - Cylindrical, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Flowserve Corporation**]
   b. [**National Oilwell Varco**]
   c. [**Nordstrom; a Flowserve Corporation brand**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Flowserve Corporation**]
   b. [**National Oilwell Varco**]
   c. [**Nordstrom; a Flowserve Corporation brand**]
   d. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type IV.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, Grade 40 cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

I. Plug Valves, Eccentric Type, Flanged Ends - with Resilient Seat, 175 CWP.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Clow Valve Company; a subsidiary of McWane, Inc.
   b. DeZURIK.
   c. Flowserve Corporation.
   d. GA Industries, Inc.
   e. Homestead Valve: a division of Olson Technologies, Inc.
   f. Kennedy Valve Company; a division of McWane, Inc.
   g. Milliken Valve Company; a Mueller brand.
   h. National Oilwell Varco.
   i. Nordstrom; a Flowserve Corporation brand.
   j. Val-Matic Valve & Manufacturing Corp.
   k. <**Insert manufacturer's name**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:
3. Standard: MSS SP-108.
4. CWP Rating: **175 psig (1200 kPa)** minimum.
5. Body and Plug: ASTM A48/A48M, gray iron; ASTM A126, gray iron; or ASTM A536, ductile iron.
6. Bearings: Oil-impregnated bronze or stainless steel.
7. Ends: Flanged.
8. Stem-Seal Packing: Asbestos free.
9. Plug, Resilient-Seat Material: Suitable for potable-water service unless otherwise indicated.

2.10 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Babbitt Steam Specialty Co**]
3. [**Roto Hammer Industries; Rotork**]
4. [**Trumbull Industries**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Babbitt Steam Specialty Co**]
3. [**Roto Hammer Industries; Rotork**]
4. [**Trumbull Industries**]
5. <**Insert manufacturer's name**>

C. Description: Valve actuation assembly with sprocket rim, chain guides, chain[**, and attachment brackets for mounting chainwheels directly to handwheels**].

1. Sprocket Rim with Chain Guides: [**Ductile iron**][**Ductile or cast iron**][**Cast iron**][**Aluminum**][**Bronze**], of type and size required for valve.[**Include zinc or epoxy coating.**]
2. Chain: [**Hot-dip, galvanized steel**][**Brass**][**Stainless steel**], of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly pressed.

F. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance,

and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to ensure that there is no leakage or damage.

H. Chainwheels: Install chainwheels on manual operators for [**globe**][**butterfly**][**gate**][**and**][**plug**] valves [**NPS 4 (DN 100)**]<**Insert pipe size**> and larger and more than [**96 inches (2400 mm)**]<**Insert dimension**> above floor. Extend chains to [**60 inches (1520 mm)**]<**Insert dimension**> above finished floor.

I. Install check valves for proper direction of flow and as follows:

1. Check Valves: [**Center-guided type**][**and**][**plate type**], in horizontal or vertical position, between flanges.
2. Check Valves, Swing Type: In horizontal position with hinge pin level.
3. Check Valves, Lift Type: With stem upright and plumb.

J. Valve Tags: Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

K. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's written recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Grooved-End Copper Tubing, except Steam and Steam Condensate Piping: Valve ends may be grooved.
8. For Grooved-End Steel Piping, except Steam and Steam Condensate Piping: Valve ends may be grooved.
9. Wafer-Type Valves: Flanged connections.

3.5 CHILLED-WATER ANGLE OR GLOBE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; [**threaded**][**soldered**] ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.6 CONDENSER-WATER ANGLE OR GLOBE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; [**threaded**][**soldered**] ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.7 HEATING-WATER ANGLE OR GLOBE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; [**threaded**][**soldered**] ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.8 LOW-PRESSURE STEAM ANGLE OR GLOBE VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; threaded ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.9 HIGH-PRESSURE STEAM ANGLE OR GLOBE VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; threaded ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.10 STEAM-CONDENSATE ANGLE OR GLOBE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; threaded ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.11 CHILLED-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, one piece.
2. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
3. Ball valves, press ends - brass, two piece with full port and brass trim.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.

5. Ball valves, press ends - brass, two piece with full port and stainless steel trim.
6. Ball valves, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
7. Ball valves, threaded or soldered ends - brass, two piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.
8. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
9. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
10. Ball valves, threaded ends - bronze, one piece with bronze trim.
11. Ball valves, threaded ends - bronze, one piece with stainless steel trim.
12. Ball valves, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
13. Ball valves, press ends - bronze, two piece with full port and bronze or brass trim.
14. Ball valves, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
15. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
16. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
17. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
18. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
19. Ball valves, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**][**soldered**] ends.
20. Ball valves, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.12 COOLING-COIL CONDENSATE BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
2. Ball valves, press ends - brass, two piece with full port and brass trim.
3. Ball valves, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
4. Ball valves, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
5. Ball valves, press ends - bronze, two piece with full port and bronze or brass trim.
6. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.

B. For CPVC Pipe:

1. CPVC Union-Type Ball Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

C. For PVC Pipe:

1. PVC Union-Type Ball Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.13 CONDENSER-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, one piece.
2. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
3. Ball valves, press ends - brass, two piece with full port and brass trim.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
5. Ball valves, press ends - brass, two piece with full port and stainless steel trim.
6. Ball valves, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
7. Ball valves, threaded or soldered ends - brass, two piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.
8. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
9. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
10. Ball valves, threaded ends - bronze, one piece with bronze trim.
11. Ball valves, threaded ends - bronze, one piece with stainless steel trim.
12. Ball valves, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
13. Ball valves, press ends - bronze, two piece with full port and bronze or brass trim.
14. Ball valves, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
15. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
16. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
17. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
18. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
19. Ball valves, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**][**soldered**] ends.
20. Ball valves, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

C. For CPVC Pipe:

1. CPVC Union-Type Ball Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F**

(23 deg C)]<**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

D. For PVC Pipe:

1. PVC Union-Type Ball Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.14 HEATING-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, one piece.
2. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
3. Ball valves, press ends - brass, two piece with full port and brass trim.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
5. Ball valves, press ends - brass, two piece with full port and stainless steel trim.
6. Ball valves, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
7. Ball valves, threaded or soldered ends - brass, two piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.
8. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
9. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
10. Ball valves, threaded ends - bronze, one piece with bronze trim.
11. Ball valves, threaded ends - bronze, one piece with stainless steel trim.
12. Ball valves, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
13. Ball valves, press ends - bronze, two piece with full port and bronze or brass trim.
14. Ball valves, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
15. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
16. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
17. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
18. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
19. Ball valves, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**][**soldered**] ends.
20. Ball valves, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.

2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.15 LOW-PRESSURE STEAM BALL VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, two piece with full port and brass trim.
2. Ball valves, threaded - brass, two piece with full port and stainless steel trim.
3. Ball valves, threaded - brass, two piece with regular port and brass trim.
4. Ball valves, threaded ends - brass, two piece with regular port and stainless steel trim.
5. Ball valves, threaded ends - brass, three piece with full port and brass trim.
6. Ball valves, threaded ends - brass, three piece with full port and stainless steel trim.
7. Ball valves, threaded ends - bronze, two piece with full port and bronze or brass trim.
8. Ball valves, threaded ends - bronze, two piece with full port and stainless steel trim.
9. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
10. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
11. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
12. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
13. Ball valves, threaded ends - bronze, three piece with regular port and bronze or brass trim.
14. Ball valves, threaded ends - bronze, three piece with regular port and stainless steel trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.16 LOW-PRESSURE CLEAN STEAM BALL VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller: Ball valves, threaded ends - stainless steel, two piece with full port.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Ball valves, flanged ends - stainless steel, two piece with full port.

3.17 HIGH-PRESSURE STEAM BALL VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, two piece with full port and brass trim.
2. Ball valves, threaded ends - brass, two piece with full port and stainless steel trim.
3. Ball valves, threaded ends - brass, two piece with regular port and brass trim.
4. Ball valves, threaded ends - brass, two piece with regular port and stainless steel trim.
5. Ball valves, threaded ends - brass, three piece with full port and brass trim.
6. Ball valves, threaded ends - brass, three piece with full port and stainless steel trim.
7. Ball valves, threaded ends - bronze, two piece with full port and bronze or brass trim.
8. Ball valves, threaded ends - bronze, two piece with full port and stainless steel trim.
9. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
10. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
11. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
12. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
13. Ball valves, threaded ends - bronze, three piece with regular port and bronze or brass trim.
14. Ball valves, threaded ends - bronze, three piece with regular port and stainless steel trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.18 HIGH-PRESSURE CLEAN STEAM BALL VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2 (DN 50) and Smaller: Ball valves, threaded ends - stainless steel, two piece with full port.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Ball valves, flanged ends - stainless steel, two piece with full port.

3.19 STEAM-CONDENSATE BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, two piece with full port and brass trim.
2. Ball valves, threaded ends - brass, two piece with full port and stainless steel trim.
3. Ball valves, threaded ends - brass, two piece with regular port and brass trim.
4. Ball valves, threaded ends - brass, two piece with regular port and stainless steel trim.
5. Ball valves, threaded ends - brass, three piece with full port and brass trim.
6. Ball valves, threaded ends - brass, three piece with full port and stainless steel trim.
7. Ball valves, threaded ends - bronze, two piece with full port and bronze or brass trim.
8. Ball valves, threaded ends - bronze, two piece with full port and stainless steel trim.
9. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
10. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
11. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
12. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
13. Ball valves, threaded ends - bronze, three piece with regular port and bronze or brass trim.
14. Ball valves, threaded ends - bronze, three piece with regular port and stainless steel trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.20 CLEAN STEAM-CONDENSATE BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Ball valves, threaded ends - stainless steel, two piece with full port.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Ball valves, flanged ends - stainless steel, two piece with full port.

3.21 CHILLED-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP,

[**EPDM**][**NBR**] seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP.
8. Butterfly valves, grooved end - ductile iron, 300 CWP.
9. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
10. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.22 CONDENSER-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc: [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP.
8. Butterfly valves, grooved end - ductile iron, 300 CWP.
9. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
10. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.23 HEATING-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc: [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP,

[**EPDM**][**NBR**] seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP.
8. Butterfly valves, grooved end - ductile iron, 300 CWP.
9. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
10. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.24 LOW-PRESSURE STEAM BUTTERFLY VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.25 LOW-PRESSURE CLEAN STEAM BUTTERFLY VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; stainless steel body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; stainless steel body.

3.26 HIGH-PRESSURE STEAM BUTTERFLY VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high-performance, Class 150 [**carbon steel**][**stainless steel**] body.
2. Butterfly valves, single flange (lug type) - high-performance, Class 300 [**carbon steel**][**stainless steel**] body.

3.27 HIGH-PRESSURE CLEAN STEAM BUTTERFLY VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; stainless steel body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; stainless steel body.

3.28 STEAM-CONDENSATE BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.29 CLEAN-STEAM-CONDENSATE BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; stainless steel body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; stainless steel body.

3.30 CHILLED-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lift type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, lift type, threaded ends - bronze, with nonmetallic disc, Class 125.
3. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
4. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
5. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
6. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.
7. Check valves, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
5. Check valves, center guided - iron, globe, with metal seat, Class 125.
6. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
7. Check valves, center guided - iron, globe, with metal seat, Class 150.
8. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
9. Check valves, center guided - iron, globe, with metal seat, Class 250.
10. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
11. Check valves, center guided - iron, globe, with metal seat, Class 300.
12. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**].
13. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**].
14. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**].
15. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**].
16. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**].
17. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**].
18. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**].
19. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**].
20. Check valves, dual-plate type - iron, with metal seat, Class 125.
21. Check valves, dual-plate type - iron, with metal seat, Class 150.
22. Check valves, dual-plate type - iron, with metal seat, Class 250.
23. Check valves, dual-plate type - iron, with metal seat, Class 300.
24. Check valves, single-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
25. Check valves, dual-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
26. Check valves, dual-plate type - iron, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
27. Check valves, single-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
28. Check valves, dual-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
29. Check valves, dual-plate type - iron, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

C. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

D. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

1. Check valves, swing type, grooved ends - iron, 300 CWP.

E. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

F. For PVC Pipe:

1. PVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.31 CONDENSER-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lift type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, lift type, threaded ends - bronze, with nonmetallic disc, Class 125.
3. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
4. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
5. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
6. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.
7. Check valves, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
5. Check valves, center guided - iron, globe, with metal seat, Class 125.
6. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
7. Check valves, center guided - iron, globe, with metal seat, Class 150.
8. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
9. Check valves, center guided - iron, globe, with metal seat, Class 250.
10. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
11. Check valves, center guided - iron, globe, with metal seat, Class 300.
12. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**].
13. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**].
14. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**].
15. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**].
16. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**].

17. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**].
18. Check valves, center guided - iron, compact water, with resilient seat, Class 300; [**EPDM**][**NBR**].
19. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**].
20. Check valves, dual-plate type - iron, with metal seat, Class 125.
21. Check valves, dual-plate type - iron, with metal seat, Class 150.
22. Check valves, dual-plate type - iron, with metal seat, Class 250.
23. Check valves, dual-plate type - iron, with metal seat, Class 300.
24. Check valves, single-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
25. Check valves, dual-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
26. Check valves, dual-plate type - iron, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
27. Check valves, single-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
28. Check valves, dual-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
29. Check valves, dual-plate type - iron, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

C. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

D. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

1. Check valves, swing type, grooved ends - iron, 300 CWP.

E. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

F. For PVC Pipe:

1. PVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.32 HEATING-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lift type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, lift type, threaded ends - bronze, with nonmetallic disc, Class 125.
3. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
4. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
5. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
6. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.
7. Check valves, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
5. Check valves, center guided - iron, globe, with metal seat, Class 125.
6. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
7. Check valves, center guided - iron, globe, with metal seat, Class 150.
8. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
9. Check valves, center guided - iron, globe, with metal seat, Class 250.
10. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
11. Check valves, center guided - iron, globe, with metal seat, Class 300.
12. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**].
13. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**].
14. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**].
15. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**].
16. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**].
17. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**].
18. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**].
19. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**].
20. Check valves, dual-plate type - iron, with metal seat, Class 125.
21. Check valves, dual-plate type - iron, with metal seat, Class 150.
22. Check valves, dual-plate type - iron, with metal seat, Class 250.
23. Check valves, dual-plate type - iron, with metal seat, Class 300.
24. Check valves, single-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
25. Check valves, dual-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
26. Check valves, dual-plate type - iron, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
27. Check valves, single-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
28. Check valves, dual-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
29. Check valves, dual-plate type - iron, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

C. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

D. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

1. Check valves, swing type, grooved ends - iron, 300 CWP.

3.33 LOW-PRESSURE STEAM CHECK VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
3. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.

4. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
5. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.34 HIGH-PRESSURE STEAM CHECK VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
3. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
5. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.35 STEAM-CONDENSATE CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
3. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
5. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.36 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Chilled-Water Pump Discharge:

1. Pipe NPS 2 (DN 50) and Smaller:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
c. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
d. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.

2. Pipe NPS 2-1/2 (DN 65) and Larger:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

c. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
d. Check valves, center guided - iron, globe, with metal seat, Class 125.
e. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
f. Check valves, center guided - iron, globe, with metal seat, Class 150.
g. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
h. Check valves, center guided - iron, globe, with metal seat, Class 250.
i. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
j. Check valves, center guided - iron, globe, with metal seat, Class 300.
k. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
l. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
m. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
n. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
o. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
p. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
q. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.
r. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

3. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

4. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

a. Check valves, swing type, grooved ends - iron, 300 CWP.

B. Condenser-Water Pump Discharge:

1. Pipe NPS 2 (DN 50) and Smaller:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150.

2. Pipe NPS 2-1/2 (DN 65) and Larger:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.
c. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
d. Check valves, center guided - iron, globe, with metal seat, Class 125.

e. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
f. Check valves, center guided - iron, globe, with metal seat, Class 150.
g. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
h. Check valves, center guided - iron, globe, with metal seat, Class 250.
i. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
j. Check valves, center guided - iron, globe, with metal seat, Class 300.
k. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
l. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
m. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
n. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
o. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
p. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
q. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.
r. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

3. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

a. Check valves, swing type, grooved-end - iron, 300 CWP.

C. Heating-Water Pump Discharge:

1. Pipe NPS 2 (DN 50) and Smaller:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150.

2. Pipe NPS 2-1/2 (DN 65) and Larger:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.
c. Check valves, center guided - iron, spring loaded, compact wafer, with metal seat, Class 125.
d. Check valves, center guided - iron, spring loaded, globe, with metal seat, Class 125.
e. Check valves, center guided - iron, spring loaded, compact wafer, with metal seat, Class 150.
f. Check valves, center guided - iron, spring loaded, globe, with metal seat, Class 150.
g. Check valves, center guided - iron, spring loaded, compact wafer, with metal seat, Class 250.
h. Check valves, center guided - iron, spring loaded, globe, with metal seat, Class 250.
i. Check valves, center guided - iron, spring loaded, compact wafer, with metal seat, Class 300.
j. Check valves, center guided - iron, spring loaded, globe, with metal seat, Class 300.

k. Check valves, center guided - iron, spring loaded, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
l. Check valves, center guided - iron, spring loaded, globe, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
m. Check valves, center guided - iron, spring loaded, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
n. Check valves, center guided - iron, spring loaded, globe, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
o. Check valves, center guided - iron, spring loaded, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
p. Check valves, center guided - iron, spring loaded, globe, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
q. Check valves, center guided - iron, spring loaded, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.
r. Check valves, center guided - iron, spring loaded, globe, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

3. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

4. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

a. Check valves, swing type, grooved ends - iron, 300 CWP.

D. Steam-Condensate Pump Discharge:

1. Pipe NPS 2 (DN 50) and Smaller:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
c. Check valves, swing type, threaded - bronze, with bronze disc, Class 150.
d. Check valves, swing type, threaded - bronze, with nonmetallic disc, Class 150.

2. Pipe NPS 2-1/2 (DN 65) and Larger for Steam Condensate Pumps:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.
c. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
d. Check valves, center guided - iron, globe, with metal seat, Class 125.
e. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
f. Check valves, center guided - iron, globe, with metal seat, Class 150.
g. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
h. Check valves, center guided - iron, globe, with metal seat, Class 250.
i. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
j. Check valves, center guided - iron, globe, with metal seat, Class 300.
k. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
l. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.

m. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
n. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
o. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
p. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
q. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.
r. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

3. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300) for Steam Condensate Pumps:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.37 CHILLED-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**][**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**][**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.
5. Gate valves, press ends - bronze; [**RS**][**NRS**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

C. CPVC Pipe:

1. CPVC Gate Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

D. PVC Pipe:

1. PVC Gate Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.38 CONDENSER-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**][**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**][**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.
5. Gate valves, press ends - bronze; [**RS**][**NRS**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

C. CPVC Pipe:

1. CPVC Gate Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

D. PVC Pipe:

1. PVC Gate Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.39 HEATING-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**][**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**][**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.
5. Gate valves, press ends - bronze; [**RS**][**NRS**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.40 LOW-PRESSURE STEAM GATE VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; threaded ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; threaded ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.41 HIGH-PRESSURE STEAM GATE VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; threaded ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; threaded ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.42 STEAM-CONDENSATE GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; threaded ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; threaded ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.43 CHILLED-WATER PLUG VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Plug valves, lubricated type, threaded ends - Class 125.
2. Plug valves, lubricated type, flanged ends - Class 125; [**Type I single gland**][**or**][**Type II regular gland**].
3. Plug valves, lubricated type, threaded ends - cylindrical, Class 125.
4. Plug valves, lubricated type, flanged ends - cylindrical, Class 125.
5. Plug valves, lubricated type, threaded ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
6. Plug valves, lubricated type, flanged ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
7. Plug valves, lubricated type, threaded ends - cylindrical, Class 250.
8. Plug valves, lubricated type, flanged ends - cylindrical, Class 250.
9. Plug valves, eccentric type, flanged ends - with resilient seat, 175 CWP.

3.44 CONDENSER-WATER PLUG VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Plug valves, lubricated type, threaded ends - Class 125.
2. Plug valves, lubricated type, flanged ends - Class 125; [**Type I single gland**][**or**][**Type II regular gland**].
3. Plug valves, lubricated type, threaded ends - cylindrical, Class 125.
4. Plug valves, lubricated type, flanged ends - cylindrical, Class 125.
5. Plug valves, lubricated type, threaded ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
6. Plug valves, lubricated type, flanged ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
7. Plug valves, lubricated type, threaded ends - cylindrical, Class 250.
8. Plug valves, lubricated type, flanged ends - cylindrical, Class 250.
9. Plug valves, eccentric type, flanged ends - with resilient seat, 175 CWP.

3.45 HEATING-WATER PLUG VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Plug valves, lubricated type, threaded ends - Class 125.
2. Plug valves, lubricated type, flanged ends - Class 125; [**Type I single gland**][**or**][**Type II regular gland**].
3. Plug valves, lubricated type, threaded ends - cylindrical, Class 125.
4. Plug valves, lubricated type, flanged ends - cylindrical, Class 125.
5. Plug valves, lubricated type, threaded ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
6. Plug valves, lubricated type, flanged ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
7. Plug valves, lubricated type, threaded ends - cylindrical, Class 250.
8. Plug valves, lubricated type, flanged ends - cylindrical, Class 250.
9. Plug valves, eccentric type, flanged ends - with resilient seat, 175 CWP.

3.46 STEAM-CONDENSATE PLUG VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Plug valves, lubricated type, threaded ends - Class 125.

2. Plug valves, lubricated type, flanged ends - Class 125; [**Type I single gland**][**or**][**Type II regular gland**].
3. Plug valves, lubricated type, threaded ends - cylindrical, Class 125.
4. Plug valves, lubricated type, flanged ends - cylindrical, Class 125.
5. Plug valves, lubricated type, threaded ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
6. Plug valves, lubricated type, flanged ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
7. Plug valves, lubricated type, threaded ends - cylindrical, Class 250.
8. Plug valves, lubricated type, flanged ends - cylindrical, Class 250.
9. Plug valves, eccentric type, flanged ends - with resilient seat, 175 CWP.

END OF SECTION 22 05 23 00A

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Task	Specification	Specification Description
22 05 23 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing
22 05 76 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing

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SECTION 22 07 16 00 - PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Calcium silicate equipment insulation.
2. Cellular glass equipment insulation.
3. Flexible elastomeric equipment insulation.
4. Glass-fiber equipment insulation.
5. Mineral wool equipment insulation.
6. Polyolefin equipment insulation.
7. Insulating cements.
8. Insulation adhesives.
9. Insulation mastics and coatings.
10. Insulation sealants.
11. Field-applied insulation jackets.
12. Field-applied fabric-reinforcing mesh for insulation.
13. Field-applied cloths for insulation.
14. Vapor-retarder tapes.
15. Insulation securements.
16. Insulation corner angles.

B. Related Requirements:

1. Section 220719 "Plumbing Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.
13. Product Data: For adhesives, mastics, and sealants, indicating VOC content.

14. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail removable insulation at equipment connections.
2. Detail application of field-applied jackets.
3. Detail application at linkages of control devices.
4. Detail field application for each equipment type.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: **12 inches (300 mm)** square.
2. Sheet Jacket Materials: **12 inches (300 mm)** square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field Quality Control Reports: For specified tests and inspections.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program [**, certified by the Department of Labor, Bureau of Apprenticeship and Training**] .

1.5 MOCKUPS

A. Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Equipment Mockups:

a. One tank or vessel.
b. One pump.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**]<**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.

5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include, the name of the manufacturer, fabricator, type, description, and size [**, as well as ASTM standard designation, and maximum use temperature**] .

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application. Before preparing equipment Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 EQUIPMENT INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Domestic Water Boiler Breeching Insulation Schedule" and "Indoor Equipment Insulation Schedule" articles for where insulating materials are to be applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel are to have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are to be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials are not to use CFC or HCFC blowing agents in the manufacturing process.

2.3 CALCIUM SILICATE EQUIPMENT INSULATION

A. Equipment Insulation - Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]
    c. <**Insert manufacturer's name**>

3. Description: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement.
4. Standard: ASTM C533, Type I or Type II.
5. Prefabricated Fitting Covers: ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.4 CELLULAR GLASS EQUIPMENT INSULATION

A. Equipment Insulation - Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Owens Corning**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Owens Corning**]

b. <**Insert manufacturer's name**>

3. Description: Cellular glass equipment insulation of inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
4. Standard: ASTM C552.
5. Block Insulation: Type I.
6. Special-Shaped Insulation: Type III.
7. Board Insulation: Type IV.
8. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
9. Equipment insulation without facing.
10. Equipment Insulation With Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
    c. FSK Facing: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
    d. FSP Facing: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type III.
    e. Vinyl Facing: White vinyl with a permeance of **1.3 perms (0.86 metric perm)** when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.5 FLEXIBLE ELASTOMERIC EQUIPMENT INSULATION

A. Equipment Insulation - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]
    d. <**Insert manufacturer's name**>

3. Description: Closed-cell or expanded-rubber flexible elastomeric equipment insulation.
4. Standard ASTM C543/ASTMC534M, Type II for sheet materials.
5. Suitable for maximum use temperature between **70 deg F (minus 57 deg C)** and **220 deg F (104 deg C)**.

2.6 GLASS-FIBER EQUIPMENT INSULATION

A. Equipment Insulation - Glass-Fiber Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

3. Description: Glass-fiber blanket equipment insulation consisting of glass fibers bonded with a thermosetting resin.
4. Suitable for maximum use temperature up to **450 deg F (232 deg C)** in accordance with ASTM C411.
5. Unfaced, Type I.
6. Factory-Applied Insulation Facing:

   a. FSK: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
   b. Vinyl: White vinyl with a permeance of **1.3 perms (0.86 metric perm)** when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

B. Equipment Insulation - High-Temperature, Glass-Fiber Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: High-temperature glass-fiber equipment blanket insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C553, Type V.
5. Unfaced.
6. Suitable for maximum use temperature up to **1000 deg F (650 deg C)**.

C. Equipment Insulation - Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: Glass-fiber board equipment insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type IA or Type IB.
5. Suitable for maximum use temperature between **35 deg F (1.7 deg C)** and **250 deg F (121 deg C)** for jacketed and between **35 deg F (1.7 deg C)** and **450 deg F (232 deg C)** for unfaced in accordance with ASTM C411.
6. Unfaced.
7. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

D. Equipment Insulation - High-Temperature, Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

3. Description: High-temperature, glass-fiber board insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type III, unfaced.
5. Suitable for maximum use temperature up to **1000 deg F (650 deg C)** in accordance with ASTM C411.

E. Equipment Insulation - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

3. Description: Glass-fiber, pipe and tank insulation consisting of glass fibers bonded with a

thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature between **35 deg F (1.7 deg C)** and **850 deg F (454 deg C)**, in accordance with ASTM C411.
6. Semirigid board material with factory-applied [**ASJ**][**FSK**] jacket.
7. Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
    b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

2.7 MINERAL WOOL EQUIPMENT INSULATION

A. Equipment Insulation - Mineral Wool Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**Owens Corning**]
    c. [**ROCKWOOL**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**Owens Corning**]
    c. [**ROCKWOOL**]
    d. <**Insert manufacturer's name**>

3. Description: Mineral wool equipment insulation blanket consisting of basalt volcanic rock-derived fibers bonded with a thermosetting resin.
4. Standard: ASTM C553.
5. Unfaced.
6. Suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447.

B. Equipment Insulation - Mineral Wool Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**Owens Corning**]
    c. [**ROCKWOOL**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool board equipment insulation consisting of basalt volcanic rock-derived fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type III, unfaced.
5. Suitable for maximum use temperature up to **1100 deg F (600 deg C)** in accordance with ASTM C411.

C. Equipment Insulation - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool, pipe and tank insulation consisting of fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facings:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

2.8 POLYOLEFIN EQUIPMENT INSULATION

A. Equipment Insulation - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

3. Description: Polyethylene type of polyolefin thermal plastic equipment insulation.
4. Standard: ASTM C1427, Type I, Grade I for tubular materials and Type II, Grade I for sheet materials.

2.9 INSULATING CEMENTS

A. Insulating Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C195.

B. Insulating Cement for Expanded or Exfoliated Vermiculite:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C196.

C. Hydraulic-Setting Insulating and Finishing Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C449.

2.10 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class I, Grade A.
4. Adhesives to be compatible with insulation materials, jackets, and substrates.
5. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
6. Service Temperature Range: [**20 to plus 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
7. Color: White.

8. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**]<**Insert number**> g/L or less.

C. Insulation Adhesive for Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Vimasco Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Vimasco Corporation**]
   e. <**Insert manufacturer's name**>

3. Description: Fibrous, sodium-silicate-based adhesive with a service temperature range of **50 to 800 deg F (10 to 427 deg C)**.
4. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

D. Insulation Adhesive for Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Description: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of **minus 100 to plus 200 deg F (minus 73 to plus 93 deg C)**.
4. Adhesive: As recommended by cellular-glass manufacturer and with a VOC content of 80 g/L or less.

E. Insulation Adhesive, Solvent Based for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]
    d. <**Insert manufacturer's name**>

3. Description: Solvent-based adhesive for flexible elastomeric and polyolefin insulation.
4. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
5. Wet Flash Point: Below **0 deg F (minus 18 deg C)**.
6. Service Temperature Range: **40 to 200 deg F (4 to plus 93 deg C)**.
7. Color: [**Black**]<**Insert color**> .
8. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of [**80**]<**Insert value**> g/L or less.

F. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.
5. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

G. Insulation Adhesive for ASJ, FSK and PVDC Facings/Jackets: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Adhesive for bonding ASJ, FSK and PVDC facing/jacket lap seams and joints.
4. Standard: MIL-A-3316C, Class 2, Grade A.
5. Verify adhesives have a VOC content of 80 g/L or less.

H. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]
   g. <**Insert manufacturer's name**>

3. Description: PVC jacket adhesive to be compatible with and as recommended in PVC jacket manufacturer's literature.

I. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.

2.11 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
2. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]
    f. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, water-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Standard: MIL-PRF-19565C, Type II, for permeance requirements [**, with supplier listing on DOD QPD - Qualified Products Database**] .
7. Color: [**White**]<**Insert color**> .

C. Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **0 to 180 deg F (Minus 18 to plus 82 deg C)**.
6. Color: [**White**]<**Insert color**> .

D. Insulation Vapor-Retarder Mastic - Solvent Based, Outdoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent-based, suitable for outdoor use on below-ambient services.
4. Water-Vapor Permeance: ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
6. Color: [**White**]<**Insert color**> .

E. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]
    f. <**Insert manufacturer's name**>

3. Description: Insulation breather mastic, water-based, suitable for indoor and outdoor use on above-ambient surfaces.
4. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perms)** at manufacturer's recommended dry film thickness.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Color: [**White**]<**Insert color**> .

2.12 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. [**Owens Corning**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. [**Owens Corning**]

e. **<Insert manufacturer's name>**

3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: [**Minus 150 to plus 250 deg F (Minus 101 to plus 121 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
5. Color: White or gray.
6. Sealant shall have a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. **<Insert manufacturer's name>**

3. Sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: Aluminum.
7. Verify sealant has a VOC content of 420 g/L or less.

C. Flashing Sealants for ASJ, PVDC, and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

3. Sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.

5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: White.
7. Verify sealant has a VOC content of 420 g/L or less.

2.13 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C1136, Type I, unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK:

1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Equipment Insulation Jacket, Field Applied - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**P.I.C. Plastics, Inc.**]
    c. [**Proto Corporation**]
    d. [**Speedline Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**P.I.C. Plastics, Inc.**]
    c. [**Proto Corporation**]
    d. [**Speedline Corporation**]
    e. <**Insert manufacturer's name**>

3. High-impact-resistant, UV-resistant PVC complying with ASTM 1784, Class 16354-C.
4. Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles.
5. Jacket: Roll stock ready for shop or field cutting and forming.
6. Adhesive: As recommended by jacket material manufacturer.
7. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] .
8. Factory-fabricated tank heads and tank side panels.

D. Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]
    c. <**Insert manufacturer's name**>

3. Jacket Material: Aluminum.

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles.
    d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
    e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
    f. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Jacket Material - Stainless Steel Jacket.

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: ASTM A240/A240M.
    c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles.
    d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
    e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
    f. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**MFM Building Products Corp.**]
    b. [**Polyguard Products, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**MFM Building Products Corp.**]
    b. [**Polyguard Products, Inc.**]
    c. <**Insert manufacturer's name**>

3. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum-foil.
4. Vapor Barrier/Waterproofing Membrane: **60-mil-** **(1.5-mm-)** thick.

F. Insulation Jacket, Field Applied - Indoor/Outdoor, Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3M**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**3M**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    d. <**Insert manufacturer's name**>

3. Description: Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors.
4. Specialized jacket to have five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive.
5. Outer aluminum surface is to be coated with UV-resistant coating for protection from environmental contaminants.
6. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
7. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
8. Aluminum Finish: [**Embossed**][**Smooth**] .
9. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

G. Insulation Jacket, Field Applied - Indoor, PVDC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. <**Insert manufacturer's name**>

3. Description: PVDC jacket for indoor applications with white PVDC biaxially oriented barrier film.
4. Vapor Barrier/Waterproofing Membrane: **4 mil (0.10 mm)** thick.
5. Permeance: **0.02 perm (0.013 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

H. Insulation Jacket, Field Applied - Outdoor, PVDC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. <**Insert manufacturer's name**>

3. Description: PVDC jacket for outdoor applications with white PVDC biaxially oriented barrier film.
4. Vapor Barrier/Waterproofing Membrane: **6 mil (0.15 mm)** thick.
5. Permeance: **0.01 perm (0.007 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

I. Insulation Jacket, Field Applied - PVDC-SSL:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. <**Insert manufacturer's name**>

3. Description: PVDC jacket with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
4. Thickness: **6 mil (0.15 mm)**.
5. Permeance: **0.01 perm (0.007 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

2.14 FIELD-APPLIED FABRIC-REINFORCING MESH FOR INSULATION

A. Woven Glass-Fiber Mesh for Equipment Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber mesh for covering equipment insulation.
4. Weight: Approximately **4 oz./sq. yd. (114 g/sq. m)**.
5. Thread Count: **5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm)**.

B. Woven Polyester Mesh for Equipment Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]

b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

3. Description: Woven polyester mesh for covering pipe and pipe fittings insulation.
4. Weight: **1 oz./sq. yd. (34 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
6. Weave Type: Leno.

2.15 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Alpha Associates, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Associates, Inc.**]
   b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber cloth.
4. Standard: MIL-C-20079H, Type I, plain weave.
5. Weave: Plain.
6. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.16 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]

c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**11.5 mils (0.29 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**6.5 mils (0.16 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**3M Industrial Adhesives and Tapes Division**]
    b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    c. <**Insert manufacturer's name**>

3. Description: White, vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
4. Suitable for indoor and outdoor applications.
5. Width: [**2 inches (50 mm)**]<**Insert value**> .
6. Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
7. Adhesion: [**64 ounces force/inch (0.7 N/mm)**]<**Insert value**> in width.
8. Elongation: 500 percent.
9. Tensile Strength: **18 lbf/inch (3.3 N/mm)** in width.

D. Vapor-Retarder Tape - Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3M Industrial Adhesives and Tapes Division**]
    b. [**Avery Dennison Corporation, Specialty Tapes Division**]
    c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    d. [**Knauf Insulation**]
    e. [**Sekisui Voltek, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**3M Industrial Adhesives and Tapes Division**]
    b. [**Avery Dennison Corporation, Specialty Tapes Division**]
    c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    d. [**Knauf Insulation**]
    e. [**Sekisui Voltek, LLC**]
    f. <**Insert manufacturer's name**>

3. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
4. Width: [**2 inches (50 mm)**]<**Insert value**> .
5. Thickness: [**3.7 mils (0.093 mm)**]<**Insert value**> .
6. Adhesion: [**100 ounces force/inch (1.1 N/mm)**]<**Insert value**> in width.
7. Elongation: [**5**]<**Insert number**> percent.
8. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**]<**Insert value**> in width.

E. Vapor-Retarder Tape - PVDC, for Indoor Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]

b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. **[Johns Manville; a Berkshire Hathaway company]**
   b. **<Insert manufacturer's name>**

3. Description: White vapor-retarder PVDC tape with acrylic adhesive, for indoor applications.
4. Width: **[3 inches (75 mm)]<Insert value>** .
5. Film Thickness: **[6 mils (0.15 mm)]<Insert value>** .
6. Adhesive Thickness: **[1.5 mils (0.04 mm)]<Insert value>** .
7. Elongation at Break: **[145]<Insert value>** percent.
8. Tensile Strength: **[55 psi (138 kPa)]<Insert value>** in width.

F. Vapor-Retarder Tape -PVDC, for Outdoor Applications:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]** :

   a. **[Johns Manville; a Berkshire Hathaway company]**
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. **[Johns Manville; a Berkshire Hathaway company]**
   b. **<Insert manufacturer's name>**

3. Description: White vapor-retarder PVDC tape with acrylic adhesive, for outdoor applications.
4. Width: **[3 inches (75 mm)]<Insert value>** .
5. Film Thickness: **[6 mils (0.15 mm)]<Insert value>** .
6. Adhesive Thickness: **[1.5 mils (0.04 mm)]<Insert value>** .
7. Elongation at Break: **[145]<Insert number>** percent.
8. Tensile Strength: **[55 psi (379 kPa)]<Insert value>** in width.

2.17 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]** :

   a. **[Johns Manville; a Berkshire Hathaway company]**
   b. **[RPR Products, Inc.]**
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

3. Insulation Bands - Stainless Steel: ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] ; **0.015 inch (0.38 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
4. Insulation Bands - Aluminum: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
5. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Insulation Pins and Hangers - Capacitor-Discharge-Weld Pins:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

c. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding.
d. Shank: [**0.106-inch- (2.6-mm-)**][**0.135-inch- (3.5-mm-)**] diameter.
e. Length: To suit depth of insulation indicated.

2. Insulation Pins and Hangers - Cupped-Head, Capacitor-Discharge-Weld Pins:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) **[AGM Industries, Inc]**
2) **[CL WARD & Family Inc.]**
3) **[Gemco]**
4) **[Midwest Fasteners, Inc]**
5) **<Insert manufacturer's name>**

c. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding.
d. Shank: [**0.106-inch- (2.6-mm-)**][**0.135-inch- (3.5-mm-)**] diameter.
e. Length: To suit depth of insulation indicated, with integral **1-1/2-inch (38-mm)** galvanized carbon-steel washer.

3. Insulation Pins and Hangers - Metal, Adhesively Attached, Perforated Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) **[AGM Industries, Inc]**
2) **[CL WARD & Family Inc.]**
3) **[Gemco]**
4) **[Midwest Fasteners, Inc]**
5) **[Nelson Stud Welding]**
6) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) **[AGM Industries, Inc]**
2) **[CL WARD & Family Inc.]**
3) **[Gemco]**
4) **[Midwest Fasteners, Inc]**
5) **[Nelson Stud Welding]**
6) **<Insert manufacturer's name>**

c. Description: Baseplate welded to projection spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
d. Baseplate: Perforated, galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
e. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated.
f. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation Hangers - Nonmetal, Adhesively Attached, Perforated Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

c. Description: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
d. Baseplate Material: Perforated, nylon sheet, **0.030 inch (0.76 mm)** thick by **1-1/2 inches (38 mm)** in diameter.
e. Spindle: Nylon, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated, up to **2-1/2 inches (63 mm)**.
f. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Insulation Hangers - Self-Sticking-Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

c. Description: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
d. Baseplate Material: Galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
e. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed; **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated.
f. Adhesive-backed base with a peel-off protective cover.

6. Insulation Washers - Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

c. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick, [**galvanized-steel**][**aluminum**][**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.

d. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Insulation Washers - Nonmetal, Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

c. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.

C. Insulation Staples: Outward-clinching insulation staples, nominal **3/4-inch- (19-mm-)** wide, stainless steel or Monel.

D. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**C & F Wire Products**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**RPR Products, Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**C & F Wire Products**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**RPR Products, Inc.**]
    d. <**Insert manufacturer's name**>

3. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

2.18 INSULATION CORNER ANGLES

A. Insulation Corner Angles - PVC:

1. Thickness: Minimum [**30-mils (0.8-mm-)**]<**Insert dimension**> .
2. Dimensions: Minimum **1- by 1-inch (25- by 25-mm)**.
3. Material: PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.

B. Insulation Corner Angles - Aluminum:

1. Thickness: Minimum [**0.040-inch (1.0-mm-)**]<**Insert dimension**> .
2. Dimensions: Minimum **1- by 1-inch (25- by 25-mm)**.
3. Material: Aluminum in accordance with **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Insulation Corner Angles - Stainless Steel:

1. Thickness: [**0.024-inch (0.61-mm-)**]<**Insert dimension**> .
2. Dimensions: Minimum **1- by 1-inch (25- by 25-mm)**.
3. Material: Stainless steel in accordance with ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that equipment to be insulated has been tested and is free of defects.

2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer **5 mils (0.127 mm)** thick and an epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 INSTALLATION OF EQUIPMENT INSULATION, GENERAL

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents [**, unless otherwise approved by the engineer of record**] .

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or area of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [**2 inches (50 mm)**][**4 inches (100 mm)**] o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

P. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on **6-inch (150-mm)** centers, starting at corners. Install **3/8-inch- (10-mm-)** diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.
2. Fabricate boxes from [**galvanized steel**][**aluminum**][**or**][**stainless steel**] , at least [**0.040 inch (1.0 mm)**][**0.050 inch (1.3 mm)**][**0.060 inch (1.6 mm)**] thick.
3. For below-ambient services, install a vapor barrier at seams, joints, and penetrations. Seal

between flanges with replaceable gasket material to form a vapor barrier.

3.4 INSTALLATION OF MINERAL WOOL EQUIPMENT INSULATION

A. Secure mineral wool equipment insulation with adhesive and anchor pins and speed washers.

B. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of tank and vessel surfaces.

C. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

D. Protect exposed corners with secured corner angles.

E. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

1. Do not weld anchor pins to ASME-labeled pressure vessels.
2. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
3. On tanks and vessels, maximum anchor-pin spacing is to be **3 inches (75 mm)** from insulation end joints and **16 inches (400 mm)** o.c. in both directions.
4. Do not compress insulation during installation.
5. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
6. Impale insulation over anchor pins, and attach speed washers.
7. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

F. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.

G. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately **6 inches (150 mm)** from each end. Install wire or cable between two circumferential girdles **12 inches (300 mm)** o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of **48 inches (1200 mm)** o.c. Use this network for securing insulation with tie wire or bands.

H. Stagger joints between insulation layers at least **3 inches (75 mm)**.

I. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

J. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

K. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.5 INSTALLATION OF GLASS-FIBER EQUIPMENT INSULATION

A. Secure glass-fiber equipment insulation with adhesive and anchor pins and speed washers.

B. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of tank and vessel surfaces.

C. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

D. Protect exposed corners with secured corner angles.

E. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

1. Do not weld anchor pins to ASME-labeled pressure vessels.
2. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
3. On tanks and vessels, maximum anchor-pin spacing is to be **3 inches (75 mm)** from insulation end joints and **16 inches (400 mm)** o.c. in both directions.
4. Do not compress insulation during installation.
5. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
6. Impale insulation over anchor pins, and attach speed washers.
7. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
8. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
9. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately **6 inches (150 mm)** from each end. Install wire or cable between two circumferential girdles **12 inches (300 mm)** o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of **48 inches (1200 mm)** o.c. Use this network for securing insulation with tie wire or bands.
10. Stagger joints between insulation layers at least **3 inches (75 mm)**.
11. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
12. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
13. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.6 INSTALLATION OF CALCIUM SILICATE EQUIPMENT INSULATION

A. On Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals, and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive

and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC EQUIPMENT INSULATION

A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.

B. Apply [**100**]<**Insert value**> percent coverage of adhesive to surface with manufacturer's recommended adhesive.

C. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Finish: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 INSTALLATION OF WOVEN GLASS-FIBER CLOTH

A. Where woven glass-fiber jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.9 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field-Applied - FSK:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field-Applied - PVC:

1. Install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
2. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field-Applied - Metal:

1. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water.
3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.

4. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

D. Insulation Jacket, Field-Applied - PVDC:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. A **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal.
2. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
3. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

E. Insulation Jacket, Field-Applied - PVDC-SSL:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of **2 inches (50 mm)** over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. The **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**]<**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**one**]<**Insert number**> location(s) for each type of equipment defined in the "Indoor Plumbing Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.12 DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48-kg/cu. m)** nominal density.
3. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu. m)** nominal density.

B. Round, concealed breeching and connector insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu m)** nominal density.

C. Rectangular, exposed breeching and connector insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - High-Temperature Glass-Fiber Board: **3 inches (75 mm)** thick and [**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu. m)** nominal density.
5. Equipment Insulation - Mineral Wool Board: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.

D. Rectangular, concealed breeching and connector insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - High-Temperature Glass-Fiber Board: **3 inches (75 mm)** thick and [**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**]<**Insert density**> nominal density.

5. Equipment Insulation - Mineral Wool Board: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.

3.13 INDOOR PLUMBING EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heat-exchanger (water-to-water for domestic water-heating service) insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inch (50 mm)**]<**Insert dimension**> thick.

D. Steam-to-hot-water converter insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inch (38 mm)**]<**Insert dimension**> thick.

E. Domestic water pump insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Blanket: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Mineral Wool Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4**

lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.

F. Domestic chilled-water (potable) pump insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [3 inches (75 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Blanket: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Equipment Insulation - Glass-Fiber Board: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: [2 inch (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
5. Equipment Insulation - Mineral Wool Board: [2 inch (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.

G. Domestic hot-water pump insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Equipment Insulation - Mineral Wool Board: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

H. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation are to be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [1.5 inch (38 mm)]<**Insert dimension**> thick.
9. Equipment Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

I. Domestic hot-water storage tank insulation is to be one of the following, of R-value indicated:

1. R-value: [**12.5**]<**Insert value**> .
2. Equipment Insulation - Cellular glass.
3. Equipment Insulation - Glass-Fiber Blanket: [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6

lb/cu. ft. (96 kg/cu. m)] nominal density.
5. Equipment Insulation - Glass-fiber pipe and tank.
6. Equipment Insulation - Mineral Wool Blanket: [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank.

J. Domestic water storage tank insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [1.5 inch (38 mm)]<**Insert dimension**> thick.
9. Equipment Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

K. Domestic chilled-water (potable) storage tank insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [1.5 inch (38 mm)]<**Insert dimension**> thick.
9. Equipment Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

L. Domestic water filter-housing insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [3 inches (75 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Blanket: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Equipment Insulation - Glass-Fiber Board: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [2 inches (50 mm)]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Blanket: [2 inch (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool Board: [2 inch (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool, Pipe and Tank: [2 inch (50 mm)]<**Insert dimension**> thick.

3.14 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

    a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

    a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

    a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

    a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Equipment, Exposed to View, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces of up to 72 Inches (1800 mm):

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

    a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

    a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

    a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

    a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

E. Equipment, Exposed to View, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.15 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] :

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] thick.

D. Equipment, Exposed to View, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces of up to 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

    a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

    a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**][**with Z-shaped locking seam**] .

    a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

E. Equipment, Exposed to View, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

    a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

    a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

    a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

END OF SECTION 22 07 16 00

SECTION 22 07 19 00 - FIRE-SUPPRESSION SYSTEMS INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Calcium silicate fire-suppression system insulation.
2. Cellular glass fire-suppression system insulation.
3. Flexible elastomeric fire-suppression system insulation.
4. Glass-fiber fire-suppression system insulation.
5. Mineral wool fire-suppression system insulation.
6. Phenolic fire-suppression system insulation.
7. Polyisocyanurate fire-suppression system insulation.
8. Polyolefin fire-suppression system insulation.
9. Insulating cements.
10. Insulation adhesives.
11. Insulation mastics and coatings.
12. Insulation sealants.
13. Field-applied insulation jackets.
14. Field-applied fabric-reinforcing mesh for insulation.
15. Field-applied cloths for insulation.
16. Vapor-retarder tapes.
17. Insulation securements.
18. Insulation corner angles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail attachment and covering of heat tracing inside insulation.
4. Detail insulation application at pipe expansion joints for each type of insulation.
5. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
6. Detail removable insulation at piping specialties and equipment connections.
7. Detail application of field-applied jackets.
8. Detail application at linkages of control devices.
9. Detail field application for fire-suppression water storage tanks.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.

2. Sheet Form Insulation Materials: **12 inches (300 mm)** square.
3. Jacket Materials for Pipe: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.
4. Sheet Jacket Materials: **12 inches (300 mm)** square.
5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

B. Field Quality Control Reports: For specified tests and inspections.

C. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program [certified by the Department of Labor, Bureau of Apprenticeship and Training] .

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size [as well as ASTM standard designation, and maximum use temperature] .

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 210529 "Hangers and Supports for Fire-Suppression Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and with equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems [**and after installing and testing heat tracing**] . Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 FIRE-SUPPRESSION SYSTEM INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Diesel Fire Pump Engine Exhaust Insulation Schedule"; "Fire-Suppression Equipment Insulation Schedule"; "Fire-Suppression System Piping Insulation Schedule, General"; "Indoor Fire-Suppression System Piping Insulation Schedule"; and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel are to have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

2.3 CALCIUM SILICATE FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Calcium Silicate, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]

2. Description: ASTM C533, flat-, curved-, and grooved-block sections of noncombustible, inorganic,

hydrous calcium silicate with a non-asbestos fibrous reinforcement, Type I.
3. Standard: ASTM C533, Type I.
4. Prefabricated Fitting Covers: ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.4 CELLULAR GLASS FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Cellular Glass, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Owens Corning**]

2. Description: Cellular-glass insulation of inorganic, incombustible, foamed, or cellulated glass with annealed, rigid, hermetically sealed cells.
3. Standard: ASTM C552.
4. Block Insulation: Type I.
5. Special-Shaped Insulation: Type III.
6. Board Insulation: Type IV.
7. Factory-fabricate shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
8. Without Insulation Facing: Type II, Class 1.
9. Factory-Applied Insulation Facing: Type II, Class 2.

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
    c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
    d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.5 FLEXIBLE ELASTOMERIC FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]

2. Description: Closed-cell or expanded-rubber flexible elastomeric pipe insulation.
3. Standard: ASTM C534/C534M, Type I, for tubular materials; Type II for sheet materials.
4. Suitable for maximum use temperature between **minus 70 and plus 220 deg F (minus 57 and plus 104 deg C)**.

2.6 GLASS-FIBER FIRE-SUPPRESSION SYSTEM INSULATION

A. Equipment Insulation - Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]

2. Description: Glass-fiber board equipment insulation consisting of glass fibers bonded with a thermosetting resin.
3. Standard: ASTM C612, Type IA or Type IB.
4. Suitable for maximum use temperature between **35 and 250 deg F (1.7 and 121 deg C)** for jacketed and between **35 and 450 deg F (1.7 and 232 deg C)** for unfaced in accordance with ASTM C411.
5. Unfaced.
6. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

B. Pipe Insulation - Glass-Fiber, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Knauf Insulation**]
   c. [**Manson Insulation Inc.**]
   d. [**Owens Corning**]

2. Description: Glass fibers bonded with a thermosetting resin.
3. Suitable for maximum use temperature up to **850 deg F (454 deg C)** in accordance with ASTM C411. Comply with ASTM C547.
4. Preformed Pipe Insulation: Type I, Grade A.
5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Unfaced.
7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.

d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

C. Pipe Insulation - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]

2. Description: Glass fibers bonded with a thermosetting resin.
3. Standard: ASTM C1393.
4. Suitable for maximum use temperature between **35 and 850 deg F (1.7 and 454 deg C)**, in accordance with ASTM C411.
5. Semirigid board material.
6. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.7 MINERAL WOOL FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Mineral Wool, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]

2. Description: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447. Comply with ASTM C547.
3. Standard: ASTM C547.
4. Preformed Pipe Insulation: Type II, Grade A.
5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Unfaced.
7. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

B. Pipe Insulation - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]

2. Description: Mineral wool fibers bonded with a thermosetting resin.
3. Standard: ASTM C1393.
4. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
5. Semirigid board material.
6. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 PHENOLIC FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Kingspan Tarec Industrial Insulation NV**]
c. [**Polyguard Products, Inc.**]
d. [**Resolco Inc.**]

2. Description: Prefabricated phenolic pipe insulation of rigid, expanded, closed-cell structure.
3. Standard: ASTM C1126.
4. Prefabricated Pipe Insulation: Type III.

5. Prefabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Unfaced.
7. Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
    c. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.9 POLYISOCYANURATE FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Duna USA Inc.**]
    b. [**Dyplast Products**]
    c. [**Johns Manville; a Berkshire Hathaway company**]

2. Description: Prefabricated, rigid cellular polyisocyanurate pipe insulation intended for use as thermal insulation.
3. Standard: ASTM C591.
4. Type IV, except thermal conductivity (k-value) to not exceed **0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K)** at **75 deg F (24 deg C)** after 180 days of aging.
5. Flame-spread index is to be 25 or less and smoke-developed index is to be 50 or less for thickness up to **1-1/2 inches (38 mm)** as tested in accordance with ASTM E84.
6. Fabricate shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.10 POLYOLEFIN FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Armacell LLC**]

2. Description: Polyethylene type of polyolefin thermal plastic insulation.

3. Standard: ASTM C1427, Type I, Grade 1, for tubular materials and with Type II, Grade 1, for sheet materials [self-seal] .

2.11 INSULATING CEMENTS

A. Insulating Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]

2. Standard: ASTM C195.

B. Insulating Cement for Expanded or Exfoliated Vermiculite:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]

2. Standard: ASTM C196.

C. Hydraulic-Setting Insulating and Finishing Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]

2. Standard: ASTM C449.

2.12 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]

2. Standard: MIL-A-3316C, Class I, Grade A.
3. Adhesives to be compatible with insulation materials, jackets, and substrates.
4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
5. Service Temperature Range: [**20 to plus 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
6. Color: White.
7. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**] g/L or less.

C. Insulation Adhesive for Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Vimasco Corporation**]

2. Description: Fibrous, sodium-silicate-based adhesive with a service temperature range of **50 to 800 deg F (10 to 427 deg C)**.
3. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

D. Insulation Adhesive for Cellular-Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]

2. Description: Two-component, thermosetting urethane containing no flammable solvent, with a service temperature range of minus **100 to plus 200 deg F (minus73 to plus 93 deg C)**.
3. Adhesive: As recommended by cellular-glass manufacturer and with a VOC content of 80 g/L or less.

E. Insulation Adhesive, Solvent Based for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**Foster Brand; H. B. Fuller**]
   d. [**K-Flex USA**]

2. Description: Solvent-based adhesive for flexible elastomeric and polyolefin insulation.
3. Flame-spread index is to be 25 or less and smoke-developed index is to be 50 or less as tested

in accordance with ASTM E84.
4. Wet Flash Point: Below **0 deg F (minus 18 deg C)**.
5. Service Temperature Range: **40 to 200 deg F (4 to plus 93 deg C)**.
6. Color: [**Black**].
7. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of [**80**] g/L or less.

F. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]

2. Standard: MIL-A-3316C, Class 2, Grade A.
3. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.
4. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

G. Insulation Adhesive - for Phenolic and Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]

2. Description: Solvent-based resin adhesive, with a service temperature range of **minus 75 to plus 300 deg F (minus 59 to plus 149 deg C)**.

H. Adhesive: As recommended by phenolic and polyisocyanate manufacturer and with a VOC content of 50 g/L or less.

I. Insulation Adhesive for ASJ, FSK, and PVDC Facings/Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]

2. Description: Insulation adhesive for bonding ASJ, FSK, and PVDC facing/jacket insulation lap seams and joints.
3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Verify adhesives have a VOC content of 80 g/L or less.
5. Verify adhesives have a VOC content of 80 g/L or less.

J. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**P.I.C. Plastics, Inc.**]
    c. [**Proto Corporation**]
    d. [**Sekisui Voltek, LLC**]
    e. [**Speedline Corporation**]
    f. [**The Dow Chemical Company**]

2. Description: PVC jacket adhesive to be compatible with and as recommended in PVC jacket manufacturer's literature.
3. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.

2.13 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

B. Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]

2. Description: Insulation vapor-retarder mastic, water based, and suitable for indoor use on below-ambient services.
3. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
4. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
5. Standard: MIL-PRF-19565C, Type II, for permeance requirements [with supplier listing on DOD's Qualified Products Database] .
6. Color: [**White**].

C. Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]

2. Description: Insulation vapor-retarder mastic, solvent based, and suitable for indoor use on below-ambient services.
3. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
4. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
5. Color: [**White**].

D. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Knauf Insulation**]
d. [**Mon-Eco Industries, Inc.**]
e. [**Vimasco Corporation**]

2. Description: Insulation breather mastic, water based, and suitable for indoor and outdoor use on above-ambient surfaces.
3. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perm)** at manufacturer's recommended dry film thickness.
4. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
5. Color: [**White**].

2.14 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. [**Owens Corning**]

2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: [**Minus 150 to plus 250 deg F (Minus 101 to plus 121 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
4. Color: White or gray.
5. Verify sealant has a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]

2. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
5. Color: Aluminum.
6. Verify sealant has a VOC content of 420 g/L or less.

C. Flashing Sealant for ASJ and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]

2. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
5. Color: White.
6. Verify sealant has a VOC content of 420 g/L or less.

2.15 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C1136, Type I unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK:

1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Insulation Jacket, Field Applied - PVC: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Airex Manufacturing Inc.**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**P.I.C. Plastics, Inc.**]
    d. [**Proto Corporation**]
    e. [**Speedline Corporation**]

2. Description: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C.
3. Thickness: As indicated in "Outdoor, Field-Applied Insulation Jacket Schedule" Article.
4. Jacket: Roll stock ready for shop or field cutting and forming.
5. Adhesive: As recommended by jacket material manufacturer.
6. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] , as directed by the Owner.
7. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, and end caps.

8. Factory-fabricated tank heads and tank side panels.

D. Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]

2. Jacket Material - Aluminum:

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" Articles.
    d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
    e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
    f. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are unavailable.

3. Jacket Material - Stainless Steel:

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: ASTM A240/A240M.
    c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" Articles.
    d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene**

and kraft paper][**3-mil- (0.075-mm-) thick polysurlyn**] .

e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .

f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are unavailable.

E. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**MFM Building Products Corp.**]
b. [**Polyguard Products, Inc.**]

2. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum-foil.
3. Vapor Barrier/Waterproofing Membrane: **60-mil (1.5-mm)** thickness.

F. Insulation Jacket, Field Applied - Indoor/Outdoor Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]

2. Description: Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors.
3. Specialized jacket consisting of five layers of laminated aluminum and polyester film.
4. Adhesive Lap: Self-adhesive, low-temperature acrylic, pressure-sensitive adhesive lap.
5. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
6. Flame Spread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
7. Aluminum Finish: [**Embossed**][**Smooth**] .
8. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

2.16 FIELD-APPLIED FABRIC-REINFORCING MESH FOR INSULATION

A. Woven Glass-Fiber Fabric for Fire-Suppression System Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Childers Brand; H. B. Fuller Construction Products**]

2. Description: Woven glass-fiber fabric for covering pipe and pipe fittings insulation.
3. Weight: Approximately **4 oz./sq. yd. (114 g/sq. m)**.
4. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.

B. Woven Glass-Fiber Fabric for Fire-Suppression System Equipment Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]** :

a. [**Childers Brand; H. B. Fuller Construction Products**]

2. Description: Woven glass-fiber fabric for covering equipment insulation.
3. Weight: Approximately **6 oz./sq. yd. (203 g/sq. m)**.
4. Thread Count: **5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm)**.

C. Woven Polyester Fabric for Fire-Suppression System Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]** :

a. [**Foster Brand; H. B. Fuller**]
b. [**Vimasco Corporation**]

2. Description: Woven polyester fabric for covering pipe, fittings, and equipment insulation.
3. Weight: Approximately **1 oz./sq. yd. (34 g/sq. m)**.
4. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
5. Weave Type: Leno.

2.17 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]** :

a. [**Alpha Associates, Inc.**]

2. Description: Woven glass-fiber cloth.
3. Standard: MIL-C-20079H, Type I.
4. Weave: Plain.
5. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.18 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3M Industrial Adhesives and Tapes Division**]
    b. [**Avery Dennison Corporation, Specialty Tapes Division**]
    c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    d. [**Knauf Insulation**]

2. Description: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
3. Standard: ASTM C1136.
4. Width: [**3 inches (75 mm)**].
5. Thickness: [**11.5 mils (0.29 mm)**].
6. Adhesion: [**90 ounces force/inch (1.0 N/mm)**] in width.
7. Elongation: [**2**] percent.
8. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**] in width.
9. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3M Industrial Adhesives and Tapes Division**]
    b. [**Avery Dennison Corporation, Specialty Tapes Division**]
    c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    d. [**Knauf Insulation**]

2. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
3. Standard: ASTM C1136.
4. Width: [**3 inches (75 mm)**].
5. Thickness: [**6.5 mils (0.16 mm)**].
6. Adhesion: [**90 ounces force/inch (1.0 N/mm)**] in width.
7. Elongation: [**2**] percent.
8. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**] in width.
9. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3M Industrial Adhesives and Tapes Division**]
    b. [**Ideal Tape Co., Inc., an American Biltrite Company**]

2. Description: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
3. Application: Suitable for indoor and outdoor applications.
4. Width: [**2 inches (50 mm)**].
5. Thickness: [**6 mils (0.15 mm)**].
6. Adhesion: [**64 ounces force/inch (0.7 N/mm)**] in width.
7. Elongation: [**500**] percent.
8. Tensile Strength: [**18 lbf/inch (3.3 N/mm)**] in width.

D. Vapor-Retarder Tape Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. [**Sekisui Voltek, LLC**]

2. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
3. Width: [**2 inches (50 mm)**].
4. Thickness: [**3.7 mils (0.093 mm)**].
5. Adhesion: [**100 ounces force/inch (1.1 N/mm)**] in width.
6. Elongation: [**5**] percent.
7. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**] in width.

2.19 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**RPR Products, Inc.**]

2. Insulation Bands - Stainless Steel: ASTM A240/A240M, [Type 304][Type 316] ; 0.015 inch (0.38 mm) thick, [1/2 inch (13 mm)][3/4 inch (19 mm)] wide with [wing seal][closed seal] .
3. Insulation Bands - Aluminum: ASTM B209 (ASTM B209M); Alloy 3003, 3005, 3105, or 5005; Temper H-14; 0.020 inch (0.51 mm) thick, [1/2 inch (13 mm)][3/4 inch (19 mm)] wide with [wing seal][closed seal] .
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Insulation Hangers - Metal, Adhesively Attached, Perforated Base:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]

b. Description: Baseplate welded to projection spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
c. Baseplate: Perforated, galvanized carbon steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
d. Spindle: [**Copper- or zinc-coated, low carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated.
e. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Insulation Hangers - Self-Sticking-Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]

b. Description: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
c. Baseplate Material: Galvanized carbon steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
d. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated.
e. Adhesive-backed base with a peel-off protective cover.

3. Insulation Washers - Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]

b. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick, [**galvanized-steel**][**aluminum**][**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.
c. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Insulation Staples: Outward-clinching insulation staples, nominal **3/4 inch (19 mm)** wide, stainless steel or Monel.

D. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**C & F Wire Products**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**RPR Products, Inc.**]

2. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

2.20 INSULATION CORNER ANGLES

A. Insulation Corner Angles - PVC:

1. Thickness: [**30 mils (0.8 mm)**].
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Insulation Corner Angles - Aluminum:

1. Thickness: [**0.040 inch (1.0 mm)**].
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: Aluminum in accordance with **ASTM B209 (ASTM B209M)**; Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Insulation Corner Angles - Stainless Steel:

1. Thickness: [**0.024 inch (0.61 mm)**].
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: Stainless steel in accordance with ASTM A240/A240M, [Type 304][Type 316] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with epoxy primer **5 mils (0.127 mm)** thick and epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range of between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 INSTALLATION OF FIRE-SUPPRESSION SYSTEM INSULATION, GENERAL

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents [unless otherwise approved by engineer of record] .

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches (50 mm)**][**4 inches (100 mm)**] o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

Q. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

R. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using [prefabricated fitting insulation][mitered or routed fittings] made from same material and density as adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with [prefabricated fitting insulation][sectional pipe insulation] of same material

and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using [prefabricated fitting insulation][sectional pipe insulation] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using [prefabricated fitting insulation][sectional pipe insulation] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

S. Insulate instrument connections for pressure gauges, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

T. Install removable insulation covers [**at locations indicated on Drawings**] . Installation complies with the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches (50 mm)** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations That Are Not Fire Rated: Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF GLASS-FIBER FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Straight Pipes and Tubes:

a. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
c. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

   a. Install prefabricated pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral wool blanket insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Insulation Installation on Pipe Fittings and Elbows:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When preformed insulation elbows and fittings are unavailable, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

4. Insulation Installation on Valves and Pipe Specialties:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When prefabricated sections are unavailable, install mitered sections of pipe insulation to valve body.
   c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   d. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF MINERAL WOOL FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Straight Pipes and Tubes:

   a. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   c. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
   d. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

   a. Install prefabricated pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral wool blanket insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Pipe Fittings and Elbows:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When preformed insulation elbows and fittings are unavailable, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

4. Valves and Pipe Specialties:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When prefabricated sections are unavailable, install mitered sections of pipe insulation to valve body.
   c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   d. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF CALCIUM SILICATE FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Straight Pipes and Tubes:

   a. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals and tighten bands without deforming insulation materials.
   b. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.
   c. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least **1 inch (25 mm)**. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

2. Pipe Flanges:

   a. Install prefabricated pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.
   d. Finish flange insulation same as pipe insulation.

3. Pipe Fittings and Elbows:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When prefabricated insulation sections of insulation are unavailable, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
   c. Finish fittings insulation same as pipe insulation.

4. Valves and Pipe Specialties:

a. Install pipe insulation, quads, hex sections, or beveled lag segments, adhered together, to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
b. Install insulation to flanges as specified for flange insulation application.
c. Finish valve and specialty insulation same as pipe insulation.

3.8 INSTALLATION OF CELLULAR-GLASS FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Straight Pipes and Tubes:

a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
c. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

a. Install prefabricated pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.
d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Pipe Fittings and Elbows:

a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
b. When preformed sections of insulation are unavailable, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

4. Valves and Pipe Specialties:

a. Install prefabricated sections of cellular-glass insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF FLEXIBLE ELASTOMERIC FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Equipment and Tanks:

a. Apply [**100**] percent coverage of adhesive to surface with manufacturer's recommended adhesive.
b. Seal longitudinal seams and end joints.

2. Pipe Flanges:

a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Pipe Fittings and Elbows:

a. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Valves and Pipe Specialties:

a. Install preformed valve covers manufactured of same material as pipe insulation when available.
b. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.
d. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Finish: After adhesive has fully cured, apply two coats of insulation and manufacturer's recommended protective coating.

3.10 INSTALLATION OF PHENOLIC FIRE-SUPPRESSION SYSTEM INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with **0.062-inch (1.6-mm)** wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.

B. Insulation on the following:

1. Straight Pipes and Tubes:

a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.

c. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

a. Install prefabricated pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.

3. Pipe Fittings and Elbows:

a. Install prefabricated insulation sections, or mitered or routed fittings, of same material as straight segments of pipe insulation.

4. Valves and Pipe Specialties:

a. Install preformed insulation sections of same material as straight segments of pipe insulation.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

3.11 INSTALLATION OF POLYISOCYANURATE FIRE-SUPPRESSION SYSTEM INSULATION

A. Insulation on the following:

1. Straight Pipes and Tubes:

a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
b. For insulation with jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
c. All insulation is tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

2. Pipe Flanges:

a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed **1-1/2-inch (38-mm)** thickness.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.

3. Fittings and Elbows:

   a. Install prefabricated sections of same material as straight segments of pipe insulation.

4. Valves and Pipe Specialties:

   a. Install prefabricated sections of polyisocyanurate insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

3.12 INSTALLATION OF POLYOLEFIN FIRE-SUPPRESSION SYSTEM INSULATION

A. Insulation on the following:

1. Straight Pipes and Tubes:

   a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive [or via self-seal mechanism] to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Pipe Flanges:

   a. Install pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
   d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Pipe Fittings and Elbows:

   a. Install mitered sections of polyolefin pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Valves and Pipe Specialties:

   a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.
   d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.13 INSTALLATION OF WOVEN GLASS-FIBER CLOTH FOR INSULATION

A. Where woven glass-fiber cloths are indicated, install directly over bare insulation or insulation with factory-applied facings.

1. Draw cloths smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.14 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field-Applied - FSK:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field-Applied - PVC:

1. Install with **1-inch (25-mm)** overlap at longitudinal seams and end joints.
2. Seal with manufacturer's recommended adhesive.
3. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field-Applied - Metal:

1. Install with **2-inch (50-mm)** overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water.
3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.
4. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

3.15 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in [**Section 099113 "Exterior Painting"**][**Section 099114 "Exterior Painting (MPI Standards)**] and [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

1. Flat Acrylic Finish: [**Two**] finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work, as directed by the Owner.

C. Do not field paint aluminum or stainless steel jackets.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**one**] location(s) for each type of equipment defined in the "Fire-Suppression Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance, as directed by the Owner.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**three**] locations of straight pipe, [**three**] locations of threaded fittings, [**three**] locations of welded fittings, [**two**] locations of threaded strainers, [**two**] locations of welded strainers, [**three**] locations of threaded valves, and [**three**] locations of flanged valves for each pipe service defined in the "Fire-Suppression System Piping Insulation Schedule, General" Article, as directed by the Owner.
3. All insulation applications will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.17 DIESEL FIRE PUMP ENGINE EXHAUST INSULATION SCHEDULE

A. Indoor and Outdoor, Exposed, Rigid, Engine Exhaust Pipe and Silencer:

1. Pipe Insulation - Calcium Silicate, Preformed: [**4 inches (100 mm)**] thick.

3.18 FIRE-SUPPRESSION EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Fire-suppression water storage tank insulation is to be one of the following:

1. Fire-Suppression System Insulation - Cellular Glass: [**2 inches (50 mm)**] thick.
2. Pipe Insulation - Flexible Elastomeric: [**1 inch (25 mm)**] thick.
3. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**] thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Pipe Insulation - Glass-Fiber, Pipe and Tank: [**1 inch (25 mm)**] thick.
5. Pipe Insulation - Mineral Wool, Pipe and Tank: [**1-1/2 inches (38 mm)**] thick.
6. Pipe Insulation - Polyisocyanurate: [**1 inch (25 mm)**] thick.
7. Pipe Insulation - Polyolefin: [**1 inch (25 mm)**] thick.

3.19 FIRE-SUPPRESSION SYSTEM PIPING INSULATION SCHEDULE, GENERAL

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Indoor fire-suppression piping.
2. Underground piping.

3.20 INDOOR FIRE-SUPPRESSION SYSTEM PIPING INSULATION SCHEDULE

A. Indoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:

1. All Pipe Sizes: Insulation is to be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**2 inches (50 mm)**] thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**] thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**] thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**] thick.

B. Indoor Fire Pump Engine Exhaust Piping and Silencer:

1. All Pipe Sizes: Insulation is to be the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**4 inches (100 mm)**] thick.

3.21 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Fire-Suppression Water Piping:

1. All Pipe Sizes: Insulation is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**] thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**] thick.
c. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**] thick.
d. Pipe Insulation - Phenolic: [**2 inches (50 mm)**] thick.

B. Outdoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:

1. All Pipe Sizes: Insulation is to be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**2 inches (50 mm)**] thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**] thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**] thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**] thick.

C. Outdoor Fire Pump Engine Exhaust Piping and Silencer:

1. All Pipe Sizes: Insulation is to be the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**4 inches (100 mm)**] thick.

D. Outdoor Fire-Suppression Piping Filled with Water:

1. All Pipe Sizes: Insulation is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**] thick.
b. Pipe Insulation Flexible Elastomeric: [**2 inches (50 mm)**] thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**] thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**] thick.
e. Pipe Insulation - Phenolic: [**2 inches (50 mm)**] thick.
f. Pipe Insulation - Polyisocyanurate: [**2 inches (50 mm)**] thick.
g. Pipe Insulation - Polyolefin: [**2 inches (50 mm)**] thick.

3.22 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed from View:

1. None.
2. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

4. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed] .

a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Piping, Exposed to View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed] .

    a. Thickness: [0.010 inch (0.25 mm)][0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)] .

3.23 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

    a. Thickness: [20 mils (0.5 mm)][30 mils (0.8 mm)] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

    a. Thickness: [0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)][0.032 inch (0.81 mm)][0.040 inch (1.0 mm)] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

    a. Thickness: [0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)][0.032 inch (0.81 mm)] .

5. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed] .

    a. Thickness: [0.010 inch (0.25 mm)][0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)] .

D. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

    a. Thickness: [0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)][0.032 inch (0.81 mm)][0.040 inch (1.0 mm)] .

2. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

    a. Thickness: [0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)][0.032 inch (0.81 mm)][0.040 inch (1.0 mm)] .

3. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed][with Z-shaped locking seam] .

    a. Thickness: [0.010 inch (0.25 mm)][0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)] .

E. Equipment, Exposed, Larger Than **48 Inches (1200 mm)** in Diameter or with Flat Surfaces Larger Than **72 Inches (1800 mm)**:

1. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) as recommended deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

2. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Stainless Steel: [Type 304][Type 316] , [smooth,][stucco embossed,] with [1-1/4-inch- (32-mm-) deep corrugations][2-1/2-inch- (65-mm-) deep corrugations][4-by-1-inch (100-by-25-mm) box ribs] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

F. Outdoor Exposed Piping:

1. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**][**40 mils (1.0 mm)**] .

2. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed][with Z-shaped locking seam] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

END OF SECTION 22 07 19 00

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SECTION 22 07 19 00A - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cellular glass pipe insulation.
2. Flexible elastomeric pipe insulation.
3. Glass-fiber pipe insulation.
4. Mineral wool pipe insulation.
5. Phenolic pipe insulation.
6. Polyolefin pipe insulation.
7. Insulating cements.
8. Insulation adhesives.
9. Insulation mastics and coatings.
10. Insulation sealants.
11. Field-applied insulation jackets.
12. Field-applied fabric-reinforcing mesh.
13. Field-applied cloths for insulation.
14. Vapor-retarder tapes.
15. Insulation securements.
16. Protective shielding guards.

B. Related Requirements:

1. Section 220716 "Plumbing Equipment Insulation" for equipment insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.
11. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
12. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail attachment and covering of heat tracing inside insulation.
4. Detail insulation application at pipe expansion joints for each type of insulation.
5. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
6. Detail removable insulation at piping specialties, equipment connections, and access panels.
7. Detail application of field-applied jackets.
8. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.
2. Jacket Materials for Pipe: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.
3. Sheet Jacket Materials: **12 inches (300 mm)** square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program [**, certified by the Department of Labor, Bureau of Apprenticeship and Training**] .

1.5 MOCKUPS

A. Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One **10-foot (3-m)** section of **NPS 2 (DN 50)** straight pipe.
b. One each of a 90-degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, and flanged tee fitting.
d. One **NPS 2 (DN 50)** or smaller valve and one **NPS 2-1/2 (DN 65)** or larger valve.

e. Four support hangers, including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One threaded reducer and one welded reducer.
h. One pressure temperature tap.
i. One mechanical coupling.
j. One union.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**]<**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size [**, as well as ASTM standard designation and maximum use temperature**] .

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems [**and after installing and testing heat tracing**] . Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical

products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 PIPING INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel are to have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are to be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials are not to use CFC or HCFC blowing agents in the manufacturing process.

2.3 CELLULAR GLASS PIPE INSULATION

A. Pipe Insulation - Cellular Glass, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Owens Corning**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Owens Corning**]
    b. <**Insert manufacturer's name**>

3. Description: Preformed pipe insulation of inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
4. Standard: ASTM C552.
5. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
6. Without Insulation Facing: Type II, Class 1.
7. Factory-Applied Insulation Facing: Type II, Class 2.

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.4 FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Pipe Insulation - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. <**Insert manufacturer's name**>

3. Description: Closed-cell or expanded-rubber flexible elastomeric pipe insulation.
4. Standard: ASTM C534/C534M, Type I, for tubular materials; Type II for sheet materials.
5. Suitable for maximum use temperature between **minus 70 deg F (minus 57 deg C)** and **220 deg F (104 deg C)**.

2.5 GLASS-FIBER PIPE INSULATION

A. Pipe Insulation - Glass-Fiber, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Knauf Insulation**]
   c. [**Manson Insulation Inc.**]
   d. [**Owens Corning**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Knauf Insulation**]
c. [**Manson Insulation Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

3. Description: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to **850 deg F (454 deg C)** in accordance with ASTM C411. Comply with ASTM C547.
4. Preformed Pipe Insulation: Type I, Grade A.
5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Unfaced.
7. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

B. Pipe Insulation - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: Glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature between **35 and 850 deg F (1.7 and 454 deg C)**, in

accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
    c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
    d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.6 MINERAL WOOL PIPE INSULATION

A. Pipe Insulation - Mineral Wool, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**Owens Corning**]
    c. [**ROCKWOOL**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**Owens Corning**]
    c. [**ROCKWOOL**]
    d. <**Insert manufacturer's name**>

3. Description: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447. Comply with ASTM C547.
4. Standard: ASTM C547.
5. Preformed Pipe Insulation: Type II, Grade A.
6. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
    c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
    d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

B. Pipe Insulation - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

3. Description: Mineral wool fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
   c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.7 PHENOLIC PIPE INSULATION

A. Pipe Insulation - Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Kingspan Tarec Industrial Insulation NV**]
   c. [**Polyguard Products, Inc.**]
   d. [**Resolco Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Kingspan Tarec Industrial Insulation NV**]
c. [**Polyguard Products, Inc.**]
d. [**Resolco Inc.**]
e. <**Insert manufacturer's name**>

3. Description: Prefabricated pipe insulation of rigid, expanded, closed-cell structure.
4. Standard: ASTM C1126.
5. Prefabricated Pipe Insulation: Type III.
6. Prefabricated shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
c. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 POLYOLEFIN PIPE INSULATION

A. Pipe Insulation - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

3. Description: Polyethylene thermal plastic insulation.
4. Standard: ASTM C1427, Type I, Grade 1, for tubular materials and with Type II, Grade 1, for sheet materials [**, self-seal**] .

2.9 INSULATING CEMENTS

A. Insulating Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C195.

B. Insulating Cement for Expanded or Exfoliated Vermiculite:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C196.

C. Hydraulic-Setting Insulating and Finishing Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C449.

2.10 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class I, Grade A.
4. Adhesives to be compatible with insulation materials, jackets, and substrates.
5. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
6. Service Temperature Range: [**20 to plus 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
7. Color: White.
8. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**]<**Insert number**> g/L or less.

C. Insulation Adhesive for Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Description: Two-component, thermosetting urethane adhesive containing no flammable solvents,

with a service temperature range of **minus 100 to plus 200 deg F (minus 73 to plus 93 deg C)**.

4. Adhesive: As recommended by cellular-glass manufacturer and with a VOC content of 80 g/L or less.

D. Insulation Adhesive, Solvent Based for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**Foster Brand; H. B. Fuller**]
    d. [**K-Flex USA**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**Foster Brand; H. B. Fuller**]
    d. [**K-Flex USA**]
    e. <**Insert manufacturer's name**>

3. Description: Solvent-based adhesive for flexible elastomeric and polyolefin insulation.
4. Flame-spread index is to be 25 or less and smoke-developed index is to be 50 or less as tested in accordance with ASTM E84.
5. Wet Flash Point: Below **0 deg F (minus 18 deg C)**.
6. Service Temperature Range: **40 to 200 deg F (4 to plus 93 deg C)**.
7. Color: [**Black**]<**Insert color**> .
8. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of [**80**]<**Insert value**> g/L or less.

E. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]

d. **<Insert manufacturer's name>**

3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.
5. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

F. Insulation Adhesive for Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

3. Description: Solvent-based resin adhesive, with a service temperature range of **minus 75 to plus 300 deg F (minus 59 to plus 149 deg C)**.
4. Adhesive: As recommended by phenolic manufacturer and with a VOC content of 50 g/L or less.

G. Insulation Adhesive for ASJ and FSK Facings/Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. **<Insert manufacturer's name>**

3. Description: Pipe insulation adhesive for bonding ASJ and FSK facing/jacket insulation lap seams and joints.
4. Standard: MIL-A-3316C, Class 2, Grade A.
5. Verify adhesives have a VOC content of 80 g/L or less.

H. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]
   g. <**Insert manufacturer's name**>

3. Description: PVC jacket adhesive to be compatible with and as recommended in PVC jacket manufacturer's literature.
4. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.

2.11 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.

B. Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Knauf Insulation**]
d. [**Mon-Eco Industries, Inc.**]
e. [**Vimasco Corporation**]
f. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, water-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Standard: MIL-PRF-19565C, Type II, for permeance requirements [**, with supplier listing on DOD QPD - Qualified Products Database**] .
7. Color: [**White**]<**Insert color**> .

C. Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **0 to 180 deg F (Minus 18 to plus 82 deg C)**.
6. Color: [**White**]<**Insert color**> .

D. Insulation Vapor-Retarder Mastic - Solvent Based, Outdoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent-based, suitable for outdoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
6. Color: [**White**]<**Insert color**> .

E. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]
    f. <**Insert manufacturer's name**>

3. Description: Insulation breather mastic, water-based, suitable for indoor and outdoor use on above-ambient surfaces.
4. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perm)** at manufacturer's recommended dry film thickness.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Color: [**White**]<**Insert color**> .

2.12 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: [**Minus 58 to plus 176 deg F (Minus 50 to plus 80 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
5. Color: White or gray.
6. Sealant shall have a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: Aluminum.
7. Verify sealant has a VOC content of 420 g/L or less.

C. Flashing Sealant for ASJ and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: White.
7. Verify sealant has a VOC content of 420 g/L or less.

2.13 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C1136, Type I, unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK:

1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Pipe Insulation Jacket, Field Applied - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Airex Manufacturing Inc.**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**P.I.C. Plastics, Inc.**]
d. [**Proto Corporation**]
e. [**Speedline Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Airex Manufacturing Inc.**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**P.I.C. Plastics, Inc.**]
d. [**Proto Corporation**]
e. [**Speedline Corporation**]
f. <**Insert manufacturer's name**>

3. Description: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C.
4. Thickness: As indicated in "Outdoor, Field-Applied Jacket Schedule" Articles under Part 3.
5. Jacket: Roll stock ready for shop or field cutting and forming.
6. Adhesive: As recommended by jacket material manufacturer.
7. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] .
8. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]
    c. <**Insert manufacturer's name**>

3. Jacket Material - Aluminum:

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
    d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
    e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
    f. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Jacket Material - Stainless Steel:

a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
b. Standard: ASTM A240/A240M.
c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Owens Corning**]
b. [**Polyguard Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Owens Corning**]
b. [**Polyguard Products, Inc.**]
c. <**Insert manufacturer's name**>

3. Description: Underground direct-buried jacket of rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
4. Vapor Barrier and Waterproofing Membrane: **125 mils (3.2 mm)** thick.

F. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**MFM Building Products Corp.**]
b. [**Polyguard Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MFM Building Products Corp.**]
   b. [**Polyguard Products, Inc.**]
   c. <**Insert manufacturer's name**>

3. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum-foil.
4. Vapor Barrier/Waterproofing Membrane: **60 mils (1.5 mm)** thick.

G. Insulation Jacket, Field Applied - Indoor/Outdoor, Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. <**Insert manufacturer's name**>

3. Description: Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors.
4. Specialized jacket consisting of five layers of laminated aluminum and polyester film.
5. Adhesive Lap: Self-adhesive, low-temperature acrylic, pressure-sensitive adhesive lap.
6. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
7. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
8. Aluminum Finish: [**Embossed**][**Smooth**] .
9. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

2.14 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh for Pipe Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber mesh for covering pipe and pipe fittings insulation.
4. Weight: Approximately **2 oz./sq. yd. (68 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.

B. Woven Polyester Mesh for Pipe Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Foster Brand; H. B. Fuller**]
    b. [**Vimasco Corporation**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Foster Brand; H. B. Fuller**]
    b. [**Vimasco Corporation**]
    c. <**Insert manufacturer's name**>

3. Description: Woven polyester mesh for covering pipe and pipe fittings insulation.
4. Weight: Approximately **1 oz./sq. yd. (34 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
6. Weave Type: Leno.

2.15 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Alpha Associates, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alpha Associates, Inc.**]
    b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber cloth.
4. Standard: MIL-C-20079H, Type I.
5. Weave: Plain.
6. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.16 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Aeroflex USA**]
   c. [**Avery Dennison Corporation, Specialty Tapes Division**]
   d. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   e. [**Knauf Insulation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Aeroflex USA**]
   c. [**Avery Dennison Corporation, Specialty Tapes Division**]
   d. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   e. [**Knauf Insulation**]
   f. <**Insert manufacturer's name**>

3. Description: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**11.5 mils (0.29 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**6.5 mils (0.16 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
c. <**Insert manufacturer's name**>

3. Description: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
4. Application: Suitable for indoor and outdoor applications.
5. Width: [**2 inches (50 mm)**]<**Insert value**> .
6. Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
7. Adhesion: [**64 ounces force/inch (0.7 N/mm)**]<**Insert value**> in width.
8. Elongation: [**500**]<**Insert value**> percent.
9. Tensile Strength: [**18 lbf/inch (3.3 N/mm)**]<**Insert value**> in width.

D. Vapor-Retarder Tape - Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]

d. [**Knauf Insulation**]
e. [**Sekisui Voltek, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. [**Sekisui Voltek, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
4. Width: [**2 inches (50 mm)**]<**Insert value**> .
5. Thickness: [**3.7 mils (0.093 mm)**]<**Insert value**> .
6. Adhesion: [**100 ounces force/inch (1.1 N/mm)**]<**Insert value**> in width.
7. Elongation: [**5**]<**Insert number**> percent.
8. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**]<**Insert value**> in width.

2.17 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

3. Insulation Bands - Stainless Steel: ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] ; **0.015 inch (0.38 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
4. Insulation Bands - Aluminum: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
5. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Staples: Outward clinching insulation staples, nominal **3/4 inch (19 mm)** wide, stainless steel or Monel.

C. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**C & F Wire Products**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**RPR Products, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**C & F Wire Products**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**RPR Products, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

2.18 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers, :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Buckaroos, Inc.**]
   b. [**McGuire Manufacturing**]
   c. [**MVG Molded Products**]
   d. [**Plumberex Specialty Products, Inc.**]
   e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   f. [**Truebro; IPS Corporation**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Buckaroos, Inc.**]
   b. [**McGuire Manufacturing**]
   c. [**MVG Molded Products**]
   d. [**Plumberex Specialty Products, Inc.**]
   e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   f. [**Truebro; IPS Corporation**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

3. Description: Manufactured plastic wraps for covering plumbing fixture [**hot-water supply**][**hot-**

and cold-water supplies] and trap and drain piping. Comply with Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines requirements.

B. Protective Shielding Piping Enclosures, :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   b. [**Truebro; IPS Corporation**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   b. [**Truebro; IPS Corporation**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

3. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA and ABA Accessibility Guidelines requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that piping to be insulated has been tested and is free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer **5 mils (0.127 mm)** thick and an epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range of between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature of between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 INSTALLATION OF PIPING INSULATION, GENERAL

A. Requirements in this article apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

E. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents [**, unless otherwise approved by the engineer-of-record**] .

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry

film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at **4 inches (100 mm)** o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least [**4 inches (100 mm)**]<**Insert value**> beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

Q. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

R. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using [**preformed fitting insulation**][**or**][**mitered or routed fittings**] made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with [**preformed fitting insulation**][**or**][**sectional pipe insulation**] of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using [**preformed fitting insulation**][**or**][**sectional pipe insulation**] of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using [**preformed fitting insulation**][**or**][**sectional pipe insulation**] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the

insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

S. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

T. Install removable insulation covers [**at locations indicated on Drawings**] . Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches (50 mm)** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations That Are Not Fire Rated: Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF CELLULAR-GLASS PIPE INSULATION

A. Installation on:

1. Straight Pipes and Tubes:

a. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
c. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

a. Install prefabricated pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Pipe Fittings and Elbows:

a. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
b. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

4. Insulation Installation on Valves and Pipe Specialties:

a. Install prefabricated sections of cellular-glass insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation on:

1. Pipe Flanges:

a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Pipe Fittings and Elbows:

a. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Valves and Pipe Specialties:

a. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
b. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.
d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Finish: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.7 INSTALLATION OF GLASS-FIBER PIPE INSULATION

A. Insulation on:

1. Straight Pipes and Tubes:

a. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
c. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

a. Install prefabricated pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Pipe Fittings and Elbows:

a. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
b. When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

4. Valves and Pipe Specialties:

a. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
b. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
d. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF PHENOLIC PIPE INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals, and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with **0.062-inch (1.6-mm)** wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.

B. Insulation on:

1. Straight Pipes and Tubes:

    a. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
    b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
    c. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
    d. For insulation with jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

    a. Install prefabricated pipe insulation to outer diameter of pipe flange.
    b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

3. Pipe Fittings and Elbows:

    a. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

4. Valves and Pipe Specialties:

    a. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
    b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
    c. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF POLYOLEFIN PIPE INSULATION

A. Insulation on:

1. Straight Pipes and Tubes:

    a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive [**, or via self-seal mechanism**] to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Pipe Flanges:

    a. Install pipe insulation to outer diameter of pipe flange.
    b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
    d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive

to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Pipe Fittings and Elbows:

   a. Install mitered sections of polyolefin pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Valves and Pipe Specialties:

   a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.
   d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 INSTALLATION OF WOVEN GLASS-FIBER CLOTH

A. Where woven glass-fiber jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.11 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field-Applied - FSK:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field-Applied - PVC:

1. Install with **1-inch (25-mm)** overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
2. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field-Applied - Metal:

1. Install with **2-inch (50-mm)** overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water.
3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.
4. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**]<**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**three**]<**Insert number**> locations of straight pipe, [**three**]<**Insert number**> locations of threaded fittings, [**three**]<**Insert number**> locations of welded fittings, [**two**]<**Insert number**> locations of threaded strainers, [**two**]<**Insert number**> locations of welded strainers, [**three**]<**Insert number**> locations of threaded valves, and [**three**]<**Insert number**> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.14 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water Piping:

1. Insulation for pipe size NPS 1 (DN 25) and smaller is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1/2 inch (13 mm)][3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1/2 inch (13 mm)][3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.

2. Insulation for pipe size NPS 1-1/4 (DN 32) and larger is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

B. Domestic Hot and Recirculated Hot Water Piping:

1. Insulation for pipe size NPS 1-1/4 (DN32) and smaller is to be one of the following:

a. Pipe Insulation - Cellular Glass Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.

2. Insulation for pipe size NPS 1-1/2 (DN 40) and larger is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

C. Domestic Chilled Water (Potable) Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

D. Stormwater and Overflow Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

E. Roof Drain and Overflow Drain Bodies:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Flexible Elastomeric: [1/2 inch (13 mm)][3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Polyolefin: [1/2 inch (13 mm)][3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.

G. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.

d. Pipe Insulation - Phenolic: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.

H. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.

I. Hot Service Drains and Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.

J. Hot Service Vent Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [2 inches (50 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [2 inches (50 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [2 inches (50 mm)]<**Insert dimension**> thick.

B. Domestic Hot and Recirculated Hot Water Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [2 inches (50 mm)]<**Insert dimension**> thick.

c. Pipe Insulation - Glass-Fiber, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [2 inches (50 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [2 inches (50 mm)]<**Insert dimension**> thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Phenolic: [2 inches (50 mm)]<**Insert dimension**> thick.

D. Hot Service Drains and Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.

E. Hot Service Vent Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.

3.17 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Pipe insulation - cellular glass, preformed [2 inches (50 mm)]<**Insert dimension**> thick.

B. Chilled Water, All Sizes: Pipe insulation - cellular glass, preformed [2 inches (50 mm)]<**Insert dimension**> thick.

3.18 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

a. Thickness: [20 mils (0.5 mm)][30 mils (0.8 mm)] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)][0.032 inch (0.81 mm)][0.040 inch (1.0 mm)] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)][0.032 inch (0.81 mm)] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

a. Thickness: [0.010 inch (0.25 mm)][0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)] .

D. Piping, Exposed to View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

a. Thickness: [20 mils (0.5 mm)][30 mils (0.8 mm)] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)][0.032 inch (0.81 mm)][0.040 inch (1.0 mm)] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)][0.032 inch (0.81 mm)] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

a. Thickness: [0.010 inch (0.25 mm)][0.016 inch (0.41 mm)][0.020 inch (0.51 mm)][0.024 inch (0.61 mm)] .

3.19 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

a. Thickness: [20 mils (0.5 mm)][30 mils (0.8 mm)] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Piping, Exposed to View:

1. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**][**40 mils (1.0 mm)**] .

2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.20 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 19 00A

SECTION 22 08 00 00 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Cx process requirements for the following plumbing systems, assemblies, and equipment:

1. Domestic hot- and cold-water piping.
2. Gray-water piping and storage.
3. Sanitary waste and vent piping.
4. Storm drainage piping.
5. Rainwater retention piping and equipment.
6. Plumbing pumps.
7. General-service compressed-air piping and equipment.
8. Plumbing equipment.
9. Compressed-air piping and equipment for laboratory and healthcare facilities.
10. Vacuum piping and equipment for laboratory and healthcare facilities.
11. Medical gases piping, equipment, and alarms.
12. Chemical waste systems for laboratory and healthcare facilities.
13. Processed-water systems for laboratory and healthcare facilities.
14. <**Insert additional systems**>.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 22 Sections specifying plumbing systems, system components, equipment, and products.

1.2 DEFINITIONS

A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

C. IAPMO: International Association of Plumbing and Mechanical Officials.

D. IgCC: International Green Construction Code.

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For plumbing testing technician.

B. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Contractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.
2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to plumbing to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements"[**, IAPMO "Green Plumbing and Mechanical Code Supplement,"**] and ASHRAE 202.

C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, provide the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

    a. Instrument or tool identification number.
    b. Equipment schedule designation of equipment for which the instrument or tool is required.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.4 QUALITY ASSURANCE

A. Plumbing Testing Technician Qualifications: Technicians to perform plumbing Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.
2. Minimum [**three years'**]<**Insert time**> experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Medical Gas Piping Systems Testing Technician Qualifications: Technicians to perform medical compressed-air, vacuum, and medical gas piping for laboratory and healthcare facilities system Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in mechanical systems, plumbing systems, or similar field. Degree requirement may be offset by three years' experience in servicing plumbing systems and gas piping for laboratory and healthcare facilities. Generally, required knowledge includes design and maintenance of gas piping for laboratory and healthcare facility systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of plumbing system equipment, assemblies, and systems.
2. Minimum [**three years'**]<**Insert time**> experience installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

    a. Be calibrated by manufacturer with current calibration tags permanently affixed.
    b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
    c. Plumbing system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 Cx PROCESS

A. Perform Cx process for plumbing systems in accordance with:

1. [**IgCC, which requires compliance with ASHRAE 202.**]
2. [**ASHRAE 202.**]
3. [**Commissioning standards acceptable to the authority having jurisdiction.**]
4. <**Insert standard**>.

3.2 CONSTRUCTION CHECKLISTS

A. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**ASHRAE 202.**][**IgCC.**][**IAPMO's "Green Plumbing and Mechanical Code Supplement."**]<**Insert Cx standard.**> Contractor performs the following:

1. Review plumbing preliminary construction checklists and provide written comments on Construction Checklist items where appropriate.
2. Return preliminary Construction Checklist with review comments within [**10**]<**Insert number**> days of receipt.
3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
4. Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.

B. Prepare preliminary detailed construction checklists for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**ASHRAE 202.**][**IgCC.**][**IAPMO's "Green Plumbing and Mechanical Code Supplement."**]<**Insert Cx standard.**>

1. Submit preliminary construction checklists to CxA and Designer for review.
2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
3. Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place as indicated Project events are completed, and provide pertinent details and other information.

C. Systems Required to Be Commissioned under IgCC:

1. Domestic hot-water systems and controls.
2. Water-pumping and -mixing systems over **5 hp (4 kW)** and purification systems.
3. Irrigation system performance that uses more than **1000 gal. (4000 L)** per day.
4. Renewable energy systems and energy storage systems.

D. Additional Systems Required to Be Commissioned:

1. Facility water-distribution piping, including the following:

    a. Domestic[**and fire-suppression**] water piping, fittings, and specialties outside the building.
    b. Pumps, motors, accessories, and controls.
    c. Outdoor water-storage tanks.
    d. Sleeves and sleeve seals.
    e. Meters and gauges.
    f. General-duty and specialty valves.
    g. Hangers and supports.
    h. Heat tracing.
    i. Vibration isolation[**and seismic restraints**].

2. Domestic water piping, including the following:

    a. Domestic cold- and hot-water piping, fittings, and specialties inside the building.
    b. Pumps, motors, accessories, and controls.
    c. Sleeves and sleeve seals.
    d. Indoor water-storage tanks.
    e. Meters and gauges.
    f. General-duty and specialty valves.
    g. Hangers and supports.
    h. Heat tracing.
    i. Vibration isolation[**and seismic restraints**].

3. Sanitary waste and vent piping, including the following:

    a. Gravity and forced-main sewerage piping, fittings, and specialties.
    b. Sanitary waste interceptors.
    c. Pumps, motors, accessories, and controls.
    d. Drains.
    e. Sleeves and sleeve seals.
    f. Meters and gauges.
    g. General-duty and specialty valves.
    h. Hangers and supports.
    i. Heat tracing.
    j. Vibration isolation[**and seismic restraints**].

4. Gray-water piping, including the following:

a. Piping, fittings, and specialties.
b. Pumps, motors, accessories, and controls.
c. Storage tanks.
d. Sleeves and sleeve seals.
e. Meters and gauges.
f. General-duty and specialty valves.
g. Hangers and supports.
h. Heat tracing.
i. Vibration isolation[**and seismic restraints**].

5. Storm-water piping, including the following:

a. Drainage piping, fittings, and specialties.
b. Pumps, motors, accessories, and controls.
c. Drains and collection basins.
d. Rainwater-collection and storage equipment.
e. Sleeves and sleeve seals.
f. Meters and gauges.
g. General-duty and specialty valves.
h. Hangers and supports.
i. Heat tracing.
j. Vibration isolation[**and seismic restraints**].

6. Plumbing fixtures, including the following:

a. Water closets, supports and connections, supplies, and flush valves.
b. Urinals, supports and connections, supplies, and flush valves.
c. Lavatories, supports, supplies, drain connections, and faucets.
d. Sinks, supports, supplies, drain connections, and faucets.
e. Tubs, drain connections, and faucets.
f. Showers, supplies, drain connections, and faucets.
g. Wash fountains, supplies, drain connections, and faucets.
h. Emergency plumbing fixtures, supplies, drain connections, and controls.
i. Drinking fountains, supplies, and drainage connections.

7. General-service compressed-air piping, including the following:

a. Piping, fittings, and specialties inside the building.
b. Compressors, motors, accessories, and controls.
c. Compressed-air outlets and connections.
d. Sleeves and sleeve seals.
e. Meters and gauges.
f. General-duty and specialty valves.
g. Hangers and supports.
h. Vibration isolation[**and seismic restraints**].

8. Compressed-air piping for laboratory and healthcare facilities, including the following:

a. Piping, fittings, and specialties inside the building.
b. Compressors, motors, accessories, and controls.
c. Medical gas alarms.
d. Compressed-air outlets and connections.
e. Sleeves and sleeve seals.
f. Meters and gauges.
g. General-duty and specialty valves.
h. Hangers and supports.

i. Vibration isolation[**and seismic restraints**].

9. Vacuum piping for laboratory and healthcare facilities, including the following:

a. Piping, fittings, and specialties inside the building.
b. Vacuum pumps, motors, accessories, and controls.
c. Medical gas alarms.
d. Vacuum terminal units and connections.
e. Sleeves and sleeve seals.
f. Meters and gauges.
g. General-duty and specialty valves.
h. Hangers and supports.
i. Vibration isolation[**and seismic restraints**].

10. Gas piping for laboratory and healthcare facilities, including the following:

a. [**Carbon-dioxide**][**helium**][**nitrogen**][**nitrous-oxide**][**and**][**oxygen**] piping, fittings, and specialties inside the building.
b. Storage tanks, manifolds, mounting devices, and accessories.
c. Medical gas alarms.
d. Medical gas terminal units and connections.
e. Sleeves and sleeve seals.
f. Meters and gauges.
g. General-duty and specialty valves.
h. Hangers and supports.
i. Vibration isolation[**and seismic restraints**].

11. Processed-water piping for laboratory and healthcare facilities, including the following:

a. Water piping, fittings, and specialties inside the building.
b. Water-purification equipment, accessories, and controls.
c. Pumps, motors, accessories, and controls.
d. Sleeves and sleeve seals.
e. Meters and gauges.
f. General-duty and specialty valves.
g. Hangers and supports.
h. Heat tracing.
i. Vibration isolation[**and seismic restraints**].

12. <**Insert additional systems**>.

3.3 Cx TESTING PREPARATION

A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that plumbing system instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and that all systems are set to and maintaining set points as required by the design documents.

C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual

position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 Cx TESTS COMMON TO PLUMBING SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response compared to acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 22 Sections specifying plumbing systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

3.6 CONSTRUCTION CHECKLIST EXAMPLES

A. Vibration Isolation in Plumbing Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration[**and seismic**] control devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**]
2. Components to Be Tested:

a. Vibration isolation control devices in plumbing systems.

b. [**Seismic control devices for proper device selection and mounting.**]
c. Support systems.

3. Test Purpose: Evaluate effectiveness of vibration isolation[**and proper installation of seismic**] control devices.
4. Test Conditions: Measure vibration of the facility structure at [**three**]<**Insert number**> locations designated by Owner's witness at the following operating conditions:

a. Maximum speed.
b. Minimum speed.
c. Critical speed.

5. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

B. Supervision of Alarms in Plumbing Systems:

1. Prerequisites: Acceptance of results of construction checklists for plumbing systems specified in the following Sections:

a. Section 220963 "Medical Gas Alarms."
b. Section 221216 "Facility Elevated, Potable-Water Storage Tanks."
c. Section 221329 "Sanitary Sewerage Pumps."
d. Section 221429 "Sump Pumps."
e. Section 223400 "Fuel-Fired, Domestic-Water Heaters."
f. Section 226113 "Compressed-Air Piping for Laboratory and Healthcare Facilities."
g. Section 226313 "Gas Piping for Laboratory and Healthcare Facilities."
h. Section 331415 "Site Water Distribution Piping."

2. Test Scope:

a. [**Supervised**][**Monitored**] plumbing system alarms.

3. Test Purpose:

a. Verify reporting of [**supervised**][**monitored**] plumbing alarm at [**building management system**][**security monitoring service**][**alarm monitoring service**][**other alarm monitoring system**]<**Insert system**>.

4. Test Conditions:

a. Alarm monitoring systems operating in normal, automatic mode.
b. Activate [**supervised**][**monitored**] plumbing alarms, one at a time.

5. Acceptance Criteria:

a. Activation of [**supervised**][**monitored**] plumbing alarm generates alarm at [**building management system**][**security monitoring service**][**alarm monitoring service**][**other alarm monitoring system**]<**Insert system**> control panel.

C. Plumbing Meter Reporting:

1. Prerequisites: Acceptance of results of construction checklists for plumbing systems specified in the following Sections :

a. Section 221119 "Domestic Water Piping Specialties."
b. Section 223100 "Domestic Water Softeners."
c. Section 331415 "Site Water Distribution Piping."

2. Test Scope:

a. [**Supervised**][**Monitored**] plumbing system water meters.

3. Test Purpose:

a. Verify accuracy of reporting of [**supervised**][**monitored**] plumbing system water meters at [**building management system**][**utility management service**][**other utility consumption management system**]<**Insert system**>.

4. Test Conditions:

a. Plumbing system water meter recording systems operating in normal, automatic mode.
b. Compare cumulative consumption data at plumbing system water meter recording systems with independent, calibrated, flow-measuring instrumentation under the following conditions:

1) Low Flow: [**1**]<**Insert number**> percent of maximum design flow rate for a period of [**four hours**]<**Insert time**>.
2) High Flow: [**80**]<**Insert number**> percent of maximum design flow rate for a period of [**20 minutes**]<**Insert time**>.

c. Activate [**supervised**][**monitored**] plumbing alarms, one at a time.

5. Acceptance Criteria:

a. Cumulative flow reported for low-flow condition is within [**5**]<**Insert number**> percent flow recorded by calibrated flow-measuring instrumentation.
b. Cumulative flow reported for high-flow condition is within [**1**]<**Insert number**> percent flow recorded by calibrated flow-measuring instrumentation.

D. Heat Tracing in Plumbing Systems:

1. Prerequisites: Acceptance of results of construction checklists for heat tracing specified in heat-tracing systems. Comply with requirements listed in Section 220533 "Heat Tracing for Plumbing Piping."
2. Equipment and Systems To Be Tested:

a. Self-regulating, parallel-resistance heating cables.
b. Heater trace circuit controller.

3. Test Purpose:

a. Evaluate response to ambient temperature below freeze-protection set point.
b. Evaluate heating cable fault alarm.

4. Test Conditions:

a. Subject temperature sensor to temperature approximately [**3 deg F (2 deg C)**]<**Insert value**> above freeze-protection set point (initial set point [**41 deg F (5 deg C)**]<**Insert value**>). Monitor sensed temperature with a calibration-grade thermometer. Gradually

change set point or sensed temperature until freeze-protection circuit is energized.

b. Subject temperature sensor to temperature approximately [**3 deg F (2 deg C)**]<**Insert value**> below freeze-protection set point (initial set point [**41 deg F (5 deg C)**]<**Insert value**>). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is de-energized.

c. Simulate an electrical fault on the heating cable.

5. Acceptance Criteria:

a. Freeze-protection circuit is energized at set-point temperature of minus **2 deg F (1 deg C)**.

b. Freeze-protection circuit is de-energized at set-point temperature of plus **2 deg F (1 deg C)**.

c. Heater trace circuit controller initiates an alarm of cable fault. Alarm is correctly reported at the fire-alarm control panel.

3.7 Cx TESTS FOR COMPRESSED-AIR SYSTEMS

A. Air Compressor Run Time:

1. Prerequisites:

a. Acceptance of results of construction checklists specified in the following:

1) Section 221519 "General-Service Packaged Air Compressors and Receivers."
2) Section 226119 "Compressed-Air Equipment for Laboratory and Healthcare Facilities."

2. Test Scope:

a. Air compressors in plumbing systems.
b. Associated compressed-air piping, valves, and appurtenances.
c. Associated air pressure controllers.

3. Test Purpose: Evaluate air compressor run time and number of compressor starts.
4. Test Conditions:

a. Keep compressed air openings closed during test.
b. For systems with multiple compressors, lock out compressor motors on all but one compressor. Repeat test for each compressor in turn.
c. Record number of air compressor motor starts during a 14-day period.
d. Record air compressor motor run time during the same 14-day period.

5. Acceptance Criteria:

a. Number of compressor motor starts during test period shall not exceed [**20**]<**Insert number**>.

b. Compressor motor run time during test period shall not exceed [**60 minutes**]<**Insert time**>.

3.8 Cx TESTS FOR VACUUM SYSTEMS

A. Vacuum Pump Run Time:

1. Prerequisites:

    a. Acceptance of results of construction checklists for vacuum equipment for laboratory and healthcare facilities.

2. Test Scope:

    a. Vacuum pumps in plumbing systems.
    b. Associated vacuum piping, valves, and appurtenances.
    c. Associated vacuum pressure controllers.

3. Test Purpose:

    a. Evaluate vacuum pump run time and number of vacuum pump starts.

4. Test Conditions:

    a. Keep vacuum piping openings closed during test.
    b. For systems with multiple vacuum pumps, lock out vacuum pump motors on all but one pump. Repeat test for each vacuum pump in turn.
    c. Record number of vacuum pump motor starts during a 14-day period.
    d. Record vacuum pump motor run time during the same 14-day period.

5. Acceptance Criteria:

    a. Number of vacuum pump motor starts during test period shall not exceed [**20**]<**Insert number**>.
    b. Vacuum pump motor run time during test period shall not exceed [**60 minutes**]<**Insert time**>.

3.9 Cx TESTS FOR PROCESSED-WATER SYSTEMS

A. Processed-Water System Tests:

1. Prerequisites: Acceptance of results of construction checklists specified for processed-water systems. Comply with requirements in Section 226713 "Processed Water Piping for Laboratory and Healthcare Facilities" and Section 226719 "Processed Water Equipment for Laboratory and Healthcare Facilities."
2. Test Scope:

    a. Processed-water equipment in plumbing systems.
    b. Associated processed-water piping, valves, and appurtenances.
    c. Processed-water point-of-use fixtures.

3. Test Purpose: Evaluate processed-water quality at points of use.
4. Test Conditions:

    a. Operate water-processing equipment and circulation pumps in normal automatic mode for seven days prior to the test.
    b. Collect processed-water samples from points of use.
    c. Collect and handle water samples in accordance with analytical laboratory recommendations.
    d. Document that the following parameters meet minimum standards required for the specified grade of processed water, as applicable:

1) Resistivity.
2) pH.
3) Total organic carbon (TOC).
4) Sodium.
5) Chloride.
6) Total silica.
7) Microbial.
8) Endotoxin.
9) Bacteria.

5. Acceptance Criteria:

a. Measured processed-water parameters shall meet the following criteria:

1) Resistivity: [**10**]<**Insert value**> megohms.
2) pH: [**6**]<**Insert value**> units.
3) TOC: [**500**]<**Insert value**> ppb.
4) Sodium: [**5**]<**Insert value**> ug/L.
5) Chloride: [**5**]<**Insert value**> ug/L.
6) Total Silica: [**3**]<**Insert value**> ug/L.
7) Microbial: [**10**]<**Insert value**> CFU/mL.
8) Endotoxin: [**0.01**]<**Insert value**> EU/mL.
9) Bacteria: [**10 CFU/100 mL**]<**Insert values**>.

END OF SECTION 22 08 00 00

SECTION 22 11 16 00 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube, drawn temper - domestic water.
2. Copper tube, annealed temper - domestic water.
3. Copper tube fittings, solder joint - domestic water.
4. Wrought-copper, solder-joint fittings - domestic water.
5. Copper tube fittings, mechanically formed tee - domestic water.
6. Copper tube appurtenances, grooved end, mechanical joint - domestic water.
7. Copper or bronze, pressure-seal-joint fittings - domestic water.
8. Copper tube, push-on-joint fittings - domestic water.
9. Ductile-iron pipe and fittings - domestic water.
10. Ductile-iron pipe appurtenances, grooved end - domestic water.
11. Stainless steel pipe and fittings - domestic water.
12. Stainless steel pipe appurtenances, grooved end, mechanical joint - domestic water.
13. Stainless steel pipe, pressure-seal-joint fittings - domestic water.
14. CPVC pipe and fittings - domestic water.
15. PVC pipe and fittings - domestic water.
16. PEX tube and fittings - domestic water.
17. PEX-AL-PEX tube and fittings - domestic water.
18. PEX-AL-HDPE tube and fittings - domestic water.
19. Polypropylene (PP-R and PP-RCT) pipe and fittings - domestic water.
20. Pipe joining materials - domestic water.
21. Encasement for piping.
22. Transition fittings - domestic water.
23. Dielectric fittings - domestic water.

B. Related Requirements:

1. Section 331415 "Site Water Distribution Piping" for water-service piping [**and water meters**] outside the building from source to the point where water-service piping enters the building.

1.2 DEFINITIONS

A. DHWR: Domestic hot water return.

B. PP-RCT: Polypropylene random copolymer with modified crystallinity and temperature resistance.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

12. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

13. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

14. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

15. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment

completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. System purging and disinfecting activities report.

C. Field Quality -Control Reports: For specified tests and inspections.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.6 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**the Owner**] no fewer than [**two**] days in advance of proposed interruption of water service.
2. Do not interrupt water service without [**Architect's**][**Construction Manager's**][**the Owner's**] written permission.

1.7 WARRANTY

A. Polypropylene (PP-R and PP-RCT) Pipe and Fittings Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.

1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of piping system due to defects in materials or manufacturing.
2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372, or be certified in compliance with NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372 by an ANSI-accredited third-party

certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Potable-water piping and components are to comply with NSF/ANSI 14, NSF/ANSI/CAN 61, and NSF/ANSI/CAN 372. [**Include marking "NSF-pw" on piping.**]

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Copper Tube, Drawn Temper - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Cambridge-Lee Industries, LLC**]
   b. [**Cerro Flow Products, LLC**]
   c. [**Mueller Streamline Co.; a company of Mueller Industries**]

2. Standard: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**][**and**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

B. Copper Tube, Annealed Temper - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Cambridge-Lee Industries, LLC**]
   b. [**Cerro Flow Products, LLC**]
   c. [**Mueller Streamline Co.; a company of Mueller Industries**]

2. Standard: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**][**and**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

C. Copper Tube Fittings, Solder Joint - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
   b. [**Mueller Streamline Co.; a company of Mueller Industries**]
   c. [**NIBCO INC.**]

D. Cast-Copper, Solder-Joint Fittings - Domestic Water: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

E. Wrought-Copper, Solder-Joint Fittings - Domestic Water: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
b. [**Mueller Streamline Co.; a company of Mueller Industries**]
c. [**NIBCO INC.**]

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

G. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

H. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

I. Copper Tube Fittings, Mechanically Formed Tee - Domestic Water: For forming T-branch on copper water tube.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**T-DRILL Industries Inc**]

2. Description: Tee formed in copper tube in accordance with ASTM F2014.

J. Copper Tube Appurtenances, Grooved End, Mechanical Joint - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**ASC Engineered Solutions**]
d. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
e. [**Victaulic Company**]

2. Source Limitations: Obtain appurtenances for grooved-end, mechanical-joint copper tube from single manufacturer.
3. Grooved-End Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
4. Grooved-End-Tube Couplings: To fit copper tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EPDM-rubber gasket, UL classified per NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372, and rated for minimum [**180 deg F (80 deg C)**] , for use with ferrous housing

and steel bolts and nuts; **300 psig (2060 kPa)** minimum CWP pressure rating.

K. Copper or Bronze, Pressure-Seal-Joint Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
   b. [**Conex Bänninger; a part of IBP Group LLC**]
   c. [**Copper Press Brand; Merit Brass Company**]
   d. [**Elkhart Brass Mfg. Co., Inc**]
   e. [**FNW; Ferguson Enterprises, Inc.**]
   f. [**Mueller Streamline Co.; a company of Mueller Industries**]
   g. [**NIBCO INC.**]
   h. [**Viega LLC**]

2. Source Limitations: Obtain copper or bronze pressure-seal-joint fittings from single manufacturer.
3. Housing: Copper.
4. O-Rings and Pipe Stops: EPDM.
5. Tools: Manufacturer's special tools.
6. Working-Pressure Rating: Minimum **200 psig (1370 kPa)** at **250 deg F (121 deg C)**.

L. Copper Tube, Push-on-Joint Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
   b. [**NIBCO INC.**]
   c. [**SharkBite, A Division of Reliance Worldwide Corporation**]

2. Source Limitations: Obtain copper tube, push-on-joint fittings from single manufacturer.
3. Description:

   a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B16.22.
   b. Stainless steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.4 DUCTILE-IRON PIPE AND FITTINGS - DOMESTIC WATER

A. Ductile-Iron Pipe, Mechanical Joint:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron Fittings, Standard Pattern, Mechanical Joint:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Ductile-Iron Fittings, Compact Pattern, Mechanical Joint:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Ductile-Iron Pipe, Push-on Joint:

1. AWWA C151/A21.51.
2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Ductile-Iron Fittings, Standard Pattern, Push-on Joint:

1. AWWA C110/A21.10, ductile or gray iron.
2. Gaskets: AWWA C111/A21.11, rubber.

F. Ductile-Iron Fittings, Compact Pattern, Push-on Joint:

1. AWWA C153/A21.53, ductile iron.
2. Gaskets: AWWA C111/A21.11, rubber.

G. Ductile-Iron Pipe, Plain End: AWWA C151/A21.51.

H. Ductile-Iron Pipe Appurtenances, Grooved End - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
    b. [**ASC Engineered Solutions**]
    c. [**SCI; an ASC Engineered Solution**]
    d. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
    e. [**Star Pipe Products**]
    f. [**Victaulic Company**]

2. Source Limitations: Obtain appurtenances for grooved-end, ductile-iron pipe from single manufacturer.
3. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions that match pipe.

4. Mechanical Couplings for Grooved-End, Ductile-Iron-Pipe:

    a. AWWA C606 for ductile-iron-pipe dimensions.
    b. Ferrous housing sections.
    c. EPDM-rubber gaskets suitable for hot and cold water.
    d. Bolts and nuts.
    e. Minimum Pressure Rating:

1) NPS 14 to NPS 18 (DN 350 to DN 450): [**250 psig (1725 kPa)**].
2) NPS 20 to NPS 46 (DN 500 to DN 1150): [**150 psig (1035 kPa)**].

2.5 STAINLESS STEEL PIPE AND FITTINGS - DOMESTIC WATER

A. Potable-Water Piping and Components: Comply with NSF/ANSI 61 and NSF/ANSI/CAN 372.

B. Stainless Steel Pipe: ASTM A312/A312M, seamless, stainless steel of types and schedules as indicated in "Domestic Water Piping Applications" Article.

C. Stainless Steel Pipe Fittings: ASTM A815/A815M.

D. Stainless Steel Pipe Appurtenances, Grooved End, Mechanical Joint - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**ASC Engineered Solutions**]
d. [**GroovJoint**]
e. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
f. [**Victaulic Company**]

2. Source Limitations: Obtain appurtenances for grooved-end, stainless steel pipe from single manufacturer.
3. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.

4. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:

a. AWWA C606 for stainless steel pipe dimensions.
b. Stainless steel housing sections.
c. Stainless steel bolts and nuts.
d. EPDM-rubber gaskets suitable for hot and cold water.
e. Minimum Pressure Rating:

1) NPS 8 (DN 200) and Smaller: [**600 psig (4137 kPa)**] .
2) NPS 10 and NPS 12 (DN 250 to DN 300): [**400 psig (2758 kPa)**].
3) NPS 14 to NPS 24 (DN 350 to DN 600): [**250 psig (1725 kPa)**].

E. Stainless Steel Pipe, Pressure-Seal-Joint Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**GroovJoint**]
c. [**Merit Brass Company**]

d. [**Victaulic Company**]
e. [**Viega LLC**]

2. Source Limitations: Obtain stainless steel pipe, pressure-seal-joint fittings from single manufacturer.
3. Material: Type 316 stainless steel, ASTM A312/A312M, [**Schedule 5**][**Schedule 10**] .
4. Fittings: Type 316 stainless steel with EPDM O-ring seal in each end, and approved for potable-water applications.
5. Listing: ICC-ES LC1002 or UL classified in accordance with NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372.
6. Working-Pressure Rating: Minimum **200 psig (1379 kPa)** at **250 deg F (121 deg C)**.

2.6 CPVC PIPE AND FITTINGS - DOMESTIC WATER

A. CPVC Pipe - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**IPEX USA LLC**]
c. [**Spears Manufacturing Company**]
d. [**Uponor Inc.**]

2. Source Limitations: Obtain CPVC pipe from single manufacturer.

3. CPVC Pipe: ASTM F441/F441M, with wall thickness as indicated in "Domestic Water Piping Applications" Article.

4. CPVC Socket Fittings: [**ASTM F438 for Schedule 40**][**and**][**ASTM F439 for Schedule 80**] .

5. CPVC Threaded Fittings: ASTM F437, Schedule 80.

B. CPVC Piping System: ASTM D2846/D2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D2846/D2846M, SDR 11, tube and socket fittings.

2.7 PVC PIPE AND FITTINGS - DOMESTIC WATER

A. PVC Pipe - Domestic Water: ASTM D1785, with wall thickness as indicated in "Domestic Water Piping Applications" Article.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain PVC pipe from single manufacturer.

B. PVC Fittings - Domestic Water: ASTM D2466, schedule 40 PVC plastic pipe fittings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain PVC fittings from single manufacturer.

3. PVC Socket Fittings: [**ASTM D2466 for Schedule 40**][**and**][**ASTM D2467 for Schedule 80**] .

4. PVC Schedule 80 Threaded Fittings: ASTM D2464.

2.8 PEX TUBE AND FITTINGS - DOMESTIC WATER

A. PEX Tube - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**HeatLink Group Inc.**]
b. [**IPEX USA LLC**]
c. [**MrPex Systems Inc**]
d. [**NIBCO INC.**]
e. [**REHAU**]
f. [**SharkBite, A Division of Reliance Worldwide Corporation**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**Uponor Inc.**]
i. [**Viega LLC**]
j. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain PEX tube from single manufacturer.
3. Tube Material: PEX plastic in accordance with ASTM F876 [**and ASTM F877**] .

B. PEX Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**NIBCO INC.**]
b. [**Oatey Co.**]
c. [**SharkBite, A Division of Reliance Worldwide Corporation**]
d. [**Uponor Inc.**]
e. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain PEX tube fittings from single manufacturer.

3. Fittings: [**ASTM F1807, metal insert and copper crimp rings**][**ASTM F1960, cold expansion fittings and reinforcing rings**] .
4. Push-Fit Fittings: ASSE/ANSI 1061, push-fit fittings.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.

2.9 PEX-AL-PEX TUBE AND FITTINGS - DOMESTIC WATER

A. PEX-AL-PEX Tube - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Heat Innovations Inc**]

2. Source Limitations: Obtain PEX-AL-PEX tube and fittings from single manufacturer.
3. PEX-AL-PEX Tube: PEX plastic bonded to inside and outside of a welded aluminum tube in accordance with ASTM F1281.

B. PEX-AL-PEX Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Heat Innovations Inc**]

2. PEX-AL-PEX Tube Fittings: ASTM F1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).

2.10 PEX-AL-HDPE TUBE AND FITTINGS - DOMESTIC WATER

A. PEX-AL-HDPE Tube - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Uponor Inc.**]
b. [**Viega LLC**]

2. Source Limitations: Obtain PEX-AL-HDPE tube and fittings from single manufacturer.

B. PEX-AL-HDPE Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Uponor Inc.**]
    b. [**Viega LLC**]

2. PEX-AL-HDPE Tube Fittings: Metal-insert type with copper or stainless steel crimp ring and matching PEX-AL-HDPE tube dimensions.

2.11 POLYPROPYLENE (PP-R AND PP-RCT) PIPE AND FITTINGS - DOMESTIC WATER

A. Polypropylene (PP-R and PP-RCT) Pipe - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**aquatherm**]
    b. [**IPEX USA LLC**]
    c. [**Nupi Americas**]
    d. [**Uponor Inc.**]

2. Source Limitations: Obtain polypropylene (PP-R and PP-RCT) pipe and fittings from single manufacturer.
3. Polypropylene (PP-R and PP-RCT) Pipe: ASTM F2389, [**SDR 7.4**][**SDR 11**] pipe pressure rating to comply with temperature and pressure ratings of code requirements for applicable service.

4. Smoke and Fire Ratings:

    a. Where indicated on Drawings that a plenum-rated piping system is required, pipe is to be wrapped and/or insulated with fiberglass or mineral-wool pipe insulation, and field installed.
    b. System is to have a flame-spread index of less than 25 and smoke-developed index of less than 50.
    c. Pipe, wrap, or insulate as a system to comply with requirements of CAN/ULC-S102.2, ASTM E84, or UL 2846.
    d. For insulation required for thermal and condensation reasons, see Section 220719 "Plumbing Piping Insulation."

5. Integration of PP-R and PP-RCT Piping Systems with Other Systems:

    a. When integrating PP-R and PP-RCT piping systems with other systems or with components not made of PP-R or PP-RCT (for example, valves, pumps, other piping, check valves, or strainers), ensure that operating parameters for PP-R and PP-RCT will not damage other materials in the system or vice versa.
    b. Verify that all parts of the system are compatible with the medium being carried before installation. PP-R and PP-RCT pipe do not require treatment to protect them from corrosion. Metals (ferrous and non-ferrous) in the system may be susceptible to corrosion. Provide water treatment to protect system metals.
    c. Do not mix PP-R and PP-RCT pipe with other piping systems in conditions that will cause the other system or components to fail.

d. For Domestic Hot Water Recirculation (DHWR) Systems:

1) When using copper piping in conjunction with PP-R and PP-RCT in a DHWR system, ensure that operating conditions will not cause degradation or erosion/corrosion of copper.
2) Follow CDA guidelines in CDA's "Copper Tube Handbook" for sizing, temperature, and flow velocity in the copper tubing.
3) Sustained high levels of copper in DHWR piping can damage components within the system, even PP-R and PP-RCT.
4) Ensure that maximum hot-water temperature within any part of the system/loop does not exceed **140 deg F (60 deg C)**. Some regulations and codes further restrict temperature at any fixture to maximum of **120 deg F (50 deg C)**. Do not exceed temperature rating of pipe for the operating pressure.
5) Maximum temperature used must not exceed rating of pipe for the operating pressure.
6) Flow rates in a DHWR system should not exceed **1.5 ft./sec (0.5 m/s)** anywhere in the system, except in some special cases where velocities up to **3 ft./sec (1 m/s)** are needed to achieve proper flow temperature.

7) When adding PP-R or PP-RCT to an existing copper system in a DHWR application, the level of copper in the water must be tested. Do not install PP-R or PP-RCT where dissolved copper levels exceed **0.1 ppm (0.1 mg/L)**.
8) Do not install PP-R or PP-RCT under the following conditions:

a) Excessive temperature above **140 deg F (60 deg C)**.
b) High flow velocity greater than **1.5 ft./s (0.5 m/s)** (or **3 ft./s (0.1 m/s)** in special cases).
c) Improper system chemistry, such as chemicals, additives, disinfectants, or corrosion products that can degrade the piping.
d) Turbulence at fittings, elbows, and abrupt direction changes.
e) Velocities greater than **8 ft./s (2 m/s)** in cold water, and **5 ft./s (2 m/s)** in hot water.
f) Transitions such as changes in direction, including bends, tees, and elbows; and at joints where fittings are improperly aligned or mismatched. These conditions are further aggravated by burrs left from improper cutting, which create micro-turbulence and concentrate stress within the piping system.

B. Polypropylene (PP-R and PP-RCT) Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**aquatherm**]
b. [**IPEX USA LLC**]
c. [**Nupi Americas**]
d. [**Uponor Inc.**]

2. Polypropylene Fittings: ASTM F2389, [**SDR 7.4**][**SDR 11**] socket-fusion, butt-fusion, electrofusion, or fusion-outlet fittings to be used for fusion-welded joints between pipe and fittings.
3. Polypropylene Mechanical Fittings and Transition Fittings: To be used where transitions are made to other piping materials or to valves and appurtenances.
4. Polypropylene Threaded Transition Fittings: Polypropylene pipe is to be unthreaded. Threaded transition fittings in accordance with ASTM F2389 to be used where a threaded connection is

required.

5. PP-R and PP-RCT Socket Fittings: ASTM F2389, [**SDR 7.4**][**SDR 11**] .

2.12 PIPE JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, **1/8 inch (3.2 mm)** thick or ASME B16.21, nonmetallic and asbestos free.
2. Full-face or ring type.

B. Metal Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

1. Product Data: Verify CPVC welding solvent cement has a VOC content of 490 g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

G. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

1. Product Data:

a. Verify PVC welding solvent cement has a VOC content of 510 g/L or less.

b. Verify adhesive primer has a VOC content of 550 g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

6. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

7. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

8. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

H. Plastic Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended in writing by piping system manufacturer.

2.13 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

1. Form: [**Sheet**][**tube**] .
2. Color: [**Black**][**natural**].

2.14 TRANSITION FITTINGS - DOMESTIC WATER

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Couplings - Domestic Water: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Dresser Pipeline Solutions**]
c. [**Ford Meter Box Company, Inc. (The)**]
d. [**JCM Industries, Inc**]
e. [**Romac Industries, Inc.**]
f. [**Smith-Blair, a Xylem brand.**]
g. [**Viking Johnson**]

2. Source Limitations: Obtain sleeve-type transition couplings from single manufacturer.

D. Plastic-to-Metal Transition Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**aquatherm**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**Sioux Chief Manufacturing Company, Inc.**]
d. [**Spears Manufacturing Company**]
e. [**Uponor Inc.**]

2. Source Limitations: Obtain plastic-to-metal transition fittings from single manufacturer.
3. Description: [**CPVC**][**PVC**] one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.

a. End Connections: One end with threaded brass insert and one solvent-cement-socket [**or threaded**] end.

E. Plastic-to-Metal Transition Unions - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Colonial Engineering, Inc.**]
b. [**NIBCO INC.**]
c. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain plastic-to-metal transition unions from single manufacturer.
3. Description: [**CPVC**][**PVC**] four-part union.

a. Threaded End: Brass [**or stainless steel**] .
b. End Connections: Solvent-cement-joint [**or threaded**] plastic end.
c. Gasket: Rubber O-ring.
d. Union nut.

2.15 DIELECTRIC FITTINGS - DOMESTIC WATER

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**HART Industrial Unions, LLC**]
d. [**Jomar Valve**]
e. [**Matco-Norca**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Wilkins**]
h. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain dielectric unions from single manufacturer.
3. Standard: ASSE/IAPMO/ANSI/CAN 1079.

4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**250 psig (1725 kPa) minimum at 180 deg F (82 deg C)**] .
5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASC Engineered Solutions**]
b. [**Capitol Manufacturing Company**]
c. [**GF Piping Systems**]
d. [**Matco-Norca**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Wilkins**]
g. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain dielectric flanges from single manufacturer.
3. Standard: ASSE/IAPMO/ANSI/CAN 1079.
4. Description: Factory-fabricated, bolted, companion-flange assembly.

5. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**175 psig (1200 kPa) minimum at 180 deg F (82 deg C)**][**300 psig (2070 kPa) minimum at 180 deg F (82 deg C)**].
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT Industries, LLC.**]

2. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
3. Description: Nonconducting materials for field assembly of companion flanges.

4. Pressure Rating: [**150 psig (1035 kPa)**] .
5. Gasket: Phenolic.
6. Temperature Rating: [**225 deg F (108 deg C)**] .
7. Bolt Sleeves: Phenolic or polyethylene.
8. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**Matco-Norca**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Victaulic Company**]

2. Source Limitations: Obtain dielectric nipples from single manufacturer.
3. Standard: IAPMO PS 66.
4. Description: Electroplated steel nipple complying with ASTM F1545.

5. Pressure Rating and Temperature: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**].
6. End Connections: Male threaded or grooved.
7. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 DOMESTIC WATER PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications in paragraphs below.

B. Flanges and unions may be used for aboveground piping joints.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-Building-Slab, Domestic Water, Building-Service Piping, NPS 3 (DN 80) and Smaller: To be the following:

1. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**] ; [**wrought-copper, solder-joint fittings; and brazed**][**copper pressure-seal-joint fittings; and pressure-sealed**] joints.
2. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
3. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

E. Under-Building-Slab, Domestic Water, Building-Service Piping, NPS 4 to NPS 8 (DN 100 to DN 200) and Larger: To be the following:

1. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**] ; wrought-copper, solder-joint fittings; and brazed joints.
2. Mechanical-Joint, Ductile-Iron Pipe: [**Standard**][**compact**] pattern, mechanical-joint fittings, and mechanical joints.
3. Push-on-Joint, Ductile-Iron Pipe: [**Standard**][**compact**] pattern, push-on-joint fittings, and gasketed joints.
4. Plain-End, Ductile-Iron Pipe: Grooved-end, ductile-iron-pipe appurtenances; and grooved joints.
5. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
6. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

F. Under-Building-Slab, Combined Domestic Water, Building-Service, and Fire-Service-Main Piping, NPS 6 to NPS 12 (DN 150 to DN 300): To be the following:

1. Mechanical-Joint, Ductile-Iron Pipe: [**Standard**][**compact**] pattern, mechanical-joint fittings, and mechanical joints.
2. Push-on-Joint, Ductile-Iron Pipe: [**Standard**][**compact**] pattern, push-on-joint fittings, and gasketed joints.
3. Plain-End, Ductile-Iron Pipe: Grooved-end, ductile-iron-pipe appurtenances; and grooved joints.

G. Under-Building-Slab, Domestic Water Piping, NPS 2 (DN 50) and Smaller: To be the following:

1. Drawn-Temper Copper Tube: **ASTM B88, Type L (ASTM B88M, Type B)**; [**wrought-copper, solder-joint fittings; and brazed**][**copper pressure-seal-joint fittings; and pressure-sealed**] joints.
2. Annealed-Temper Copper Tube: **ASTM B88, Type L (ASTM B88M, Type B)**; [**wrought-copper, solder-joint fittings; and brazed**][**copper pressure-seal-joint fittings; and pressure-sealed**] joints.
3. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
4. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

H. Aboveground Domestic Water Piping, NPS 2 (DN 50) and Smaller: To be the following:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

    a. [**Cast-copper**][**wrought-copper**] solder-joint fittings and [**brazed**][**soldered**] joints.
    b. Copper pressure-seal-joint fittings and pressure-sealed joints.
    c. Copper push-on-joint fittings; and push-on joints.

2. Stainless Steel Pipe: [**Schedule 5**][**Schedule 10**] , pressure-seal-joint fittings, and pressure-sealed joints.
3. CPVC Pipe: [**Schedule 40 socket fittings and solvent-cemented joints**][**Schedule 80 socket fittings and solvent-cemented joints**][**Schedule 80 pipe; CPVC, Schedule 80 threaded**

fittings; and threaded joints] .

4. CPVC Tubing System: CPVC tube, CPVC socket fittings, and solvent-cemented joints. [**NPS 1-1/2 (DN 40) and NPS 2 (DN 50) CPVC pipe with CPVC socket fittings may be used instead of tubing.**]

5. PEX Tube - Domestic Water: **NPS 1 (DN 25)** and smaller.

    a. Fittings for PEX tube:

        1) ASTM F1807, metal insert and copper crimp rings.
        2) ASTM F1960, cold expansion fittings and reinforcing rings.
        3) ASSE/ANSI 1061, push-fit fittings.

6. PEX-AL-PEX Tube: **NPS 1 (DN 25)** and smaller, fittings for PEX-AL-PEX tube, and crimped joints.
7. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
8. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

I. Aboveground Domestic Water Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): To be the following:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

    a. [**Cast-copper**][**wrought-copper**] solder-joint fittings and [**brazed**][**soldered**] joints.
    b. Copper pressure-seal-joint fittings and pressure-sealed joints.
    c. Grooved-end, copper-tube appurtenances; and grooved joints.

2. Stainless Steel Pipe: [**Schedule 5**][**Schedule 10**][**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.
3. CPVC Pipe: [**Schedule 40, socket fittings, and solvent-cemented joints**][**Schedule 80, socket fittings, and solvent-cemented joints**][**Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints**] .
4. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

J. Aboveground Domestic Water Piping, NPS 5 to NPS 8 (DN 125 to DN 200): To be the following:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

    a. [**Cast-copper**][**wrought-copper**] solder-joint fittings and [**brazed**][**soldered**] joints.
    b. Grooved-end, copper-tube appurtenances; and grooved joints.

2. Stainless Steel Pipe: [**Schedule 5**][**Schedule 10**][**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.

3. CPVC Pipe: [**Schedule 40, socket fittings, and solvent-cemented joints**][**Schedule 80, socket fittings, and solvent-cemented joints**][**Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints**] .
4. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

K. Aboveground, Combined Domestic Water-Service and Fire-Service-Main Piping, NPS 6 to NPS 12 (DN 150 to DN 300): To be the following:

1. Plain-End, Ductile-Iron Pipe: Grooved-end, ductile-iron-pipe appurtenances; and grooved joints.
2. Stainless Steel Pipe: [**Schedule 5**][**Schedule 10**][**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF DOMESTIC WATER PIPING, GENERAL

A. Requirements in this article apply to all piping materials, except where more specific requirements are specified in various pipe and fittings installation articles.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

C. Install valves in accordance with Section 220523 "General-Duty Valves for Plumbing Piping."

D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

E. Install domestic water piping level [**with 0.25 percent slope downward toward drain**][**without pitch**] and plumb.

F. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.

G. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping to permit valve servicing.

L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220500 "Common Work Results for Plumbing."

P. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic-Water Pumps."

Q. Install thermometers on [**inlet and**] outlet piping from each water heater. Comply with requirements for thermometers in Section 220500 "Common Work Results for Plumbing."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

U. Joint Construction, General:

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
3. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

4. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 INSTALLATION OF COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Install copper tubing under building slab in accordance with CDA's "Copper Tube Handbook."

B. Install underground copper tube in polyethylene encasement in accordance with ASTM A674 or AWWA C105/A21.5.

C. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

D. Joint Construction:

1. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
2. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."
3. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended in writing by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

4. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gauge. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
5. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
6. Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

3.5 INSTALLATION OF DUCTILE-IRON PIPE AND FITTINGS - DOMESTIC WATER

A. Install ductile-iron piping under building slab with restrained joints in accordance with AWWA C600 and AWWA M41.

B. Install underground ductile-iron pipe in polyethylene encasement in accordance with ASTM A674 or AWWA C105/A21.5.

C. Joint Construction:

1. Grooved-End, Ductile-Iron Piping: Make joints in accordance with AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
2. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

3.6 INSTALLATION OF STAINLESS STEEL PIPE AND FITTINGS - DOMESTIC WATER

A. Joint Construction of Grooved-End Steel Piping: Make joints in accordance with AWWA C606. [**Square cut**][**Roll**] groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

3.7 INSTALLATION OF CPVC PIPE AND FITTINGS - DOMESTIC WATER

A. Joint Construction of Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. Join in accordance with ASTM D2846/D2846M.

3.8 INSTALLATION OF PVC PIPE AND FITTINGS - DOMESTIC WATER

A. Joint Construction of Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

2. Join in accordance with ASTM D2855.

3.9 INSTALLATION OF PEX TUBE AND FITTINGS - DOMESTIC WATER

A. Install PEX tube with loop at each change of direction of more than 90 degrees.

B. Joint Construction:

1. Joints for PEX Tubing, ASTM: Join in accordance with ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.
2. Joints for PEX Tubing, ASSE: Join in accordance with ASSE/ANSI 1061 for push-fit fittings.

3.10 INSTALLATION OF PEX-AL-PEX TUBE AND FITTINGS - DOMESTIC WATER

A. Install PEX-AL-PEX tubing and fittings per manufacturer instructions.

B. Joint Connection:

1. Joints PEX-AL-PEX Tubing, ASTM: Join in accordance with using approved mechanical compression, press, or crimp fittings per ASTM F1281.

3.11 INSTALLATION OF PEX-AL-HDPE TUBE AND FITTINGS - DOMESTIC WATER

A. Install PEX-AL-HDPE tubing and fittings per manufacturer instructions.

B. Joint Connections:

1. Joints for PEX-AL-HDPE Tubing: Join in accordance with manufacturer's written instructions and standard ISO/EN.

3.12 INSTALLATION OF POLYPROPYLENE PIPING AND FITTINGS - DOMESTIC WATER

A. Install Polypropylene piping and fitting per manufacturer's instructions.

B. Joint Connections:

1. Jointing Polypropylene Piping and Fittings, ASTM and ISO: Join by the use of the thermal fusion method specifically approved by the manufacturer based on ASTM F2389 and ISO 15874.

3.13 INSTALLATION OF TRANSITION FITTINGS - DOMESTIC WATER

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal

transition [**fittings**][**unions**] .

3.14 INSTALLATION OF DIELECTRIC FITTINGS - DOMESTIC WATER

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [**couplings**][**couplings or nipples**][**nipples**][**unions**] .

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [**flanges**][**flange kits**][**nipples**] .

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.15 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Metal Tube/Pipe:

1. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of metal tube/pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Plastic Pipe:

1. Install vinyl-coated hangers with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of plastic pipe to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. PEX Tube:

1. Install vinyl-coated hangers for PEX tube, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of PEX tube to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within [**12 inches (300 mm)**] of each fitting.

3.16 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for **NPS 2-1/2 (DN 65)** and larger.

3.17 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.18 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system in accordance with either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least **50 ppm (50 mg/L)** of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least **200 ppm (200 mg/L)** of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.19 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.20 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

e. Polypropylene (PP-R and PP-RCT) Pipe: Hydrostatic testing and documentation of test results for polypropylene (PP-R and PP-RCT) pipe to be in accordance with manufacturer's written instructions and submitted to manufacturer upon successful completion per warranty requirements.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 22 11 16 00

SECTION 22 11 16 00A - GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Piping and related specialties for general-service compressed-air systems, as follows:

1. Pipes, tubes, and fittings.
2. Joining materials.
3. Valves.
4. Dielectric fittings.
5. Flexible pipe connectors.
6. Specialties.
7. Quick couplings.
8. Hose assemblies.

B. Related Requirements:

1. Section 221519 "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. HDPE: High-density polyethylene plastic.

D. High-Pressure, Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between **150 and 200 psig (1035 and 1380 kPa)**.

E. Low-Pressure, Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of **150 psig (1035 kPa)** or less.

F. NBR: Nitrile butadiene rubber.

G. PE: Polyethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Plastic pipes, fittings, and valves.
2. Dielectric fittings.
3. Flexible pipe connectors.
4. Safety valves.
5. Pressure regulators. Include rated capacities and operating characteristics.
6. Automatic drain valves.

7. Filters. Include rated capacities and operating characteristics.
8. Lubricators. Include rated capacities and operating characteristics.
9. Quick couplings.
10. Hose assemblies.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates:

1. [**Brazing**][**and**][**welding**] certificates.

B. Field quality-control reports.

C. Qualification Statements: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by respective manufacturer, for making branch outlets.
2. Press-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by respective manufacturer.
3. Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by respective manufacturer.
4. Joining Procedures for Aluminum Piping Systems: Qualify installers according to training provided by respective manufacturer.

B. Brazing: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or with AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

C. Welding: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air piping system to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the piping system will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for high-pressure, compressed-air piping.
2. Comply with ASME B31.3, "Process Piping," for high- and low-pressure, compressed-air piping.
3. Comply with ASME B31.9, "Building Services Piping," for low-pressure, compressed-air piping.

2.3 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A53/A53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded in accordance with ASME B1.20.1.

1. Steel Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
4. Steel Flanges, Threaded: ASME B16.5, Class 150 or 300, carbon steel, threaded.
5. Wrought-Steel, Butt-Welding Fittings: ASME B16.9, Schedule 40.
6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
7. Grooved-End Fittings and Couplings, Steel:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Anvil; an ASC Engineered Solution**]
2) [**ASC Engineered Solutions**]
3) [**Star Pipe Products**]
4) [**Victaulic Company**]
5) [**Ward Manufacturing LLC**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of

the following:

1) [**Anvil; an ASC Engineered Solution**]
2) [**ASC Engineered Solutions**]
3) [**Star Pipe Products**]
4) [**Victaulic Company**]
5) [**Ward Manufacturing LLC**]
6) <**Insert manufacturer's name**>

c. Grooved-End Fittings: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings; with grooves in accordance with AWWA C606 and dimensions matching steel pipe.

d. Grooved-End Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for **300 psig (2070 kPa)** minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.

B. Schedule 5, Steel Pipe: ASTM A135, carbon steel with plain ends and zinc-plated finish.

1. Press-Type, Schedule 5 Steel, Fittings: Listed and labeled by qualified testing agency and FM Global-approved, carbon-steel, pressure-seal housing with O-ring end seals suitable for compressed-air piping and rated for **300 psig (2070 kPa)** minimum working pressure. Provide EDPM seals for oil-free compressed air. Provide NBR seals if compressed air contains oil or oil vapor.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Victaulic Company**]
3) [**Viega LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Victaulic Company**]
3) [**Viega LLC**]
4) <**Insert manufacturer's name**>

C. Copper Tube: [**ASTM B88, Type K or L (ASTM B88M, Type A or B)**] seamless, drawn-temper, water tube.

1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
3. Copper Unions: ASME B16.22 or MSS SP-123.
4. Press-Type, Copper Tube, Fittings, **NPS 2 (DN 50)** and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**NIBCO INC.**]
3) [**Viega LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**NIBCO INC.**]
3) [**Viega LLC**]
4) <**Insert manufacturer's name**>

5. Press-Type, Copper Tube, Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Bronze fitting with stainless steel grip ring and EPDM O-ring seal in each end.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**NIBCO INC.**]
2) [**Viega LLC**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**NIBCO INC.**]
2) [**Viega LLC**]
3) <**Insert manufacturer's name**>

6. Extruded-Tee Outlets: Procedure for making branch outlets in copper tube in accordance with ASTM F2014.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**T-DRILL Industries Inc**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**T-DRILL Industries Inc**]
2) <**Insert manufacturer's name**>

7. Grooved-End Fittings and Couplings, Copper:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Anvil; an ASC Engineered Solution**]
        2) [**ASC Engineered Solutions**]
        3) [**Victaulic Company**]
        4) <**Insert manufacturer's name**>

    b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

        1) [**Anvil; an ASC Engineered Solution**]
        2) [**ASC Engineered Solutions**]
        3) [**Victaulic Company**]
        4) <**Insert manufacturer's name**>

    c. Grooved-End Fittings: ASTM B75/B75M, copper tube or ASTM B584, bronze castings.
    d. Grooved-End Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gasket for oil-free compressed air. Provide NBR gasket if compressed air contains oil or oil vapor.

D. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

E. Aluminum Piping System: Aluminum pipe, Alloy Grade AA 6035-T5, for push-connect bite ring couplings, and roll-groove couplings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Applied System Technologies**]
    b. [**Gardner Denver, an Ingersoll Rand business**]
    c. [**Ingersoll Rand**]
    d. [**SynergAir**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Applied System Technologies**]
    b. [**Gardner Denver, an Ingersoll Rand business**]
    c. [**Ingersoll Rand**]
    d. [**SynergAir**]
    e. <**Insert manufacturer's name**>

3. Pressure and Temperature Range: Aluminum piping and related specialties for general-service

compressed-air systems operating at **220 psig (1517 kPa)** or less, across a temperature range of **minus 4 to plus 176 deg F (minus 20 to plus 80 deg C)**.

4. Tubing, 14 to 273 mm: Aluminum pipe, Alloy Grade AA 6063-T5.
5. Pipe Coating: Powder-coated paint that is certified nontoxic to AAMA 603 and AAMA 605, blue for compressed air.
6. Provide tubing that is quality controlled to comply with tolerances specified by roll-groove or push-to-connect coupling manufacturer. Tubing manufacturer follows ISO 9001:2000 quality standards.
7. Pipe Identification: Decal with maximum working pressure and temperature on each length of pipe.
8. Push-Connect Bite Ring Couplings, 14 to 63 mm: Solid-brass and nickel-plated body, NBR O-ring seal in excess of 36 percent, and AISI Type 304 stainless steel clamping washer.
9. Fittings: Solid brass and nickel plated.
10. Roll-Groove Couplings, 73 to 273 mm: Solid ductile-iron, galvanized, ASTM A536 Grade 65-45-12, NBR standard seals, and fluoroelastomer seals for high-temperature applications.
11. Ball Valves, 20 to 63 mm: NPT ends, or push-connect bite ring ends.
12. Butterfly Valves, 73 to 273 mm: Tube to tube, with two roll-groove end couplings.
13. Flanges, 73 to 273 mm: ASME B16.5, Class 150.

F. Blue ABS Piping System: Made of ASTM D3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are light blue and sizes are in millimeters.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**IPEX USA LLC**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**IPEX USA LLC**]
    b. <**Insert manufacturer's name**>

3. Transition Fittings, 20 to 63 mm: Composite union with ABS socket end, CR O-ring, and malleable-iron union nut and threaded end; with construction similar to MSS SP-107, transition union.
4. Transition Fittings, 90 to 110 mm: Flange assembly with ABS flange, CR gasket, and metal flange of material matching piping to be connected.
5. Valves, 20 to 63 mm: ABS union ball valve with socket ends.
6. Valves, 90 to 110 mm: ABS butterfly valve with lever handle.

G. Green ABS Piping System: Made of ASTM D3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark green with SDR of 9.0 and same OD as ASTM A53/A53M, steel pipe.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**NIBCO INC.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**NIBCO INC.**]
    b. <**Insert manufacturer's name**>

3. Transition Fittings, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: Composite union with ABS socket end, CR O-ring, ABS union nut, and brass solder-joint end; with construction similar to MSS SP-107, transition union.
4. Transition Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: ABS flange, CR gasket, and metal flange of material matching piping to be connected.
5. Valves, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: Union ball valve with socket ends.
6. Valves, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Union ball valve with flanged ends. Include safety exhaust feature in "Valve Applications" Article if required.

H. HDPE Piping System: Made of ASTM D1248, HDPE resin to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark blue with pipe dimensions about the same OD as ASTM D3035, PE pipe.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Asahi/America**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Asahi/America**]
    b. <**Insert manufacturer's name**>

3. Transition Fittings, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: HDPE adapter with one socket end and one end with threaded brass insert.
4. Transition Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: HDPE flange, CR gasket, and metal flange of material matching piping to be connected.
5. Valves, **NPS 1/2 to NPS 3 (DN 15 to DN 80)**: HDPE union ball valve with socket ends.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system

manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux in accordance with ASTM B813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D2235.

2.5 VALVES

A. Metal Ball, Butterfly, Check, and Gate Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Capitol Manufacturing Company**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**HART Industrial Unions, LLC**]
e. [**Jomar Valve**]
f. [**Matco-Norca**]
g. [**Viega LLC**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Wilkins**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Capitol Manufacturing Company**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**HART Industrial Unions, LLC**]
e. [**Jomar Valve**]
f. [**Matco-Norca**]
g. [**Viega LLC**]

h. [**WATTS; A Watts Water Technologies Company**]
i. [**Wilkins**]
j. <**Insert manufacturer's name**>

3. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Capitol Manufacturing Company**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. [**Matco-Norca**]
d. [**Viega LLC**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Wilkins**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Capitol Manufacturing Company**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. [**Matco-Norca**]
d. [**Viega LLC**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Wilkins**]
g. <**Insert manufacturer's name**>

3. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**].
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]

b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

3. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**>.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.7 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Engineered Solutions**]
2. [**Flex-Hose Co., Inc**]
3. [**Flexicraft Industries**]
4. [**Hyspan Precision Products, Inc**]
5. [**Kadant Unaflex, LLC**]
6. [**Mercer Rubber Co**]
7. [**Metraflex Company (The)**]
8. [**Proco Products, Inc**]
9. [**Universal Metal Hose**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ASC Engineered Solutions**]
2. [**Flex-Hose Co., Inc**]
3. [**Flexicraft Industries**]
4. [**Hyspan Precision Products, Inc**]
5. [**Kadant Unaflex, LLC**]
6. [**Mercer Rubber Co**]
7. [**Metraflex Company (The)**]
8. [**Proco Products, Inc**]
9. [**Universal Metal Hose**]
10. <**Insert manufacturer's name**>

C. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and

ends brazed to inner tubing.

1. Working-Pressure Rating: [200 psig (1380 kPa)][250 psig (1725 kPa)] minimum.
2. End Connections, NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections, NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

D. Stainless Steel-Hose Flexible Pipe Connectors: Corrugated, stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: [200 psig (1380 kPa)][250 psig (1725 kPa)] minimum.
2. End Connections, NPS 2 (DN 50) and Smaller: Threaded steel pipe nipple.
3. End Connections, NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.8 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [250 psig (1725 kPa)]<**Insert pressure**> inlet pressure, unless otherwise indicated.

1. Type: Pilot operated.

C. Air-Line Pressure Regulators, Bronze Body: [**Diaphragm**][**or**][**pilot**] operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [200 psig (1380 kPa)]<**Insert pressure**> minimum inlet pressure, unless otherwise indicated.

D. Air-Line Pressure Regulators, Aluminum Alloy or Plastic Body: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [200 psig (1380 kPa)]<**Insert pressure**> minimum inlet pressure, unless otherwise indicated.

E. Automatic Drain Valves: Stainless steel body and internal parts, rated for [200 psig (1380 kPa)]<**Insert pressure**> minimum working pressure, capable of automatic discharge of collected condensate.[**Include mounting bracket if wall mounting is indicated.**]

F. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded.[**Include mounting bracket if wall mounting is indicated.**]

G. Mechanical Filters: Two-stage, mechanical-separation, air-line filters. Equip with deflector plates, resin-impregnated-ribbon filters with edge filtration, and drain cock.[**Include mounting bracket if wall mounting is indicated.**]

H. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering airstream; with oil-feed adjustment screw and quick-release collar for easy bowl removal.[**Include mounting bracket if wall mounting is indicated.**]

1. Provide with automatic feed device for supplying oil to lubricator.

2.9 QUICK COUPLINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aeroquip Performance Products; Eaton, Hydraulics Sector**]
2. [**Bowes Manufacturing Inc.**]
3. [**Foster Manufacturing, Inc.**]
4. [**Milton Industries, Inc**]
5. [**Parker (Parker Hannifin)**]
6. [**Rectus Corp**]
7. [**Schrader-Bridgeport/Standard Thomson**]
8. [**TOMCO Products Inc**]
9. [**Tuthill Corporation**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aeroquip Performance Products; Eaton, Hydraulics Sector**]
2. [**Bowes Manufacturing Inc.**]
3. [**Foster Manufacturing, Inc.**]
4. [**Milton Industries, Inc**]
5. [**Parker (Parker Hannifin)**]
6. [**Rectus Corp**]
7. [**Schrader-Bridgeport/Standard Thomson**]
8. [**TOMCO Products Inc**]
9. [**Tuthill Corporation**]
10. <**Insert manufacturer's name**>

C. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

D. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless steel or nickel-plated-steel operating parts.

1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
2. Plug End: [**Flow-sensor-bleeder, check-valve**][**Straight-through**] type with barbed outlet for attaching hose.

E. Valveless Quick Couplings: Straight-through brass body with stainless steel or nickel-plated-steel operating parts.

1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
2. Plug End: With barbed outlet for attaching hose.

2.10 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for [**300 psig (2070 kPa)**]<**Insert pressure**> minimum working

pressure, unless otherwise indicated.

1. Hose: Reinforced [**single-**][**or**][**double**]-wire-braid, CR-covered hose for compressed-air service.
2. Hose Clamps: Stainless steel clamps or bands.
3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
4. Hose Splicers: One-piece, straight-through brass or stainless steel fitting with barbed ends for connecting two sections of hose.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use[**one of**] the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller, Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
2. NPS 2 (DN 50) and Smaller, Pressure-Sealed: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and press-seal joints.
3. NPS 2 (DN 50) and Smaller, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
4. NPS 2 (DN 50) and Smaller, Brazed: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed joints.
5. 63 mm Outside Tube Diameter and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.
6. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
7. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Grooved-End: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
8. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
9. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Brazed: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed joints.
10. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Grooved-End, Copper: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
11. 73 to 115 mm: Aluminum pipe; and roll-groove couplings.
12. NPS 5 (DN 125) and Larger, Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
13. NPS 5 (DN 125) and Larger, Grooved-End: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
14. NPS 5 (DN 125) and Larger, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
15. NPS 5 (DN 125) and Larger, Grooved-End, Copper: Grooved-end, **ASTM B88, Type K or L (ASTM B88M, Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
16. 168 mm and Larger: Aluminum pipe; and roll-groove couplings.

B. Low-Pressure Compressed-Air Distribution Piping: Use[**one of**] the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller, Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.

2. NPS 2 (DN 50) and Smaller, Pressure-Sealed, Steel: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
3. NPS 2 (DN 50) and Smaller, Brazed or Soldered: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
4. NPS 2 (DN 50) and Smaller, Pressure-Sealed, Copper: **Type K or L (Type A or B)**, copper tube; press-type fittings; and pressure-sealed joints.
5. 63 mm and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bit ring couplings.
6. 63 mm and Smaller, Solvent-Fitted, Blue ABS: Pipe and fittings; transition fittings; valves; and solvent-cemented joints.
7. NPS 2 (DN 50) and Smaller, Solvent-Fitted, Green ABS: Pipe and fittings, transition fittings, and valves; and solvent-cemented joints.
8. NPS 2 (DN 50) and Smaller, Heat-Fused: HDPE pipe, fittings, and valves; and heat-fusion joints.
9. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
10. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Grooved-End: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
11. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Brazed or Soldered: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
12. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Grooved-End, Copper: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
13. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Pressure-Sealed: **Type K or L (Type A or B)**, copper tube; press-type fittings; and pressure-sealed joints.
14. 73 to 115 mm: Aluminum pipe; and roll-groove couplings.
15. 90 and 110 mm, Solvent-Fitted, Blue ABS: Pipe and fittings; transition fittings; and solvent-cemented joints. Include butterfly valves and flanged joints.
16. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Solvent-Fitted, Green ABS: Green ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include ball valves and flanged joints.
17. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Heat-Fused: HDPE pipe and fittings; valves; and heat-fusion joints.
18. NPS 5 and NPS 6 (DN 125 and DN 150): Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
19. NPS 5 (DN 125) and Larger: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
20. NPS 5 to NPS 8 (DN 125 to DN 200): **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
21. 169 to 273 mm: Aluminum pipe; and roll-groove couplings.

C. High-Pressure Compressed-Air Distribution Piping: Use[**one of**] the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller, Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
2. NPS 2 (DN 50) and Smaller, Pressure-Sealed: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
3. NPS 2 (DN 50) and Smaller, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
4. NPS 2 (DN 50) and Smaller, Brazed or Soldered: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
5. 63 mm and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.
6. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
7. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Grooved-End: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
8. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Welded: Schedule 40, black-steel pipe; wrought-steel

fittings; and welded joints.

9. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
10. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Brazed: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed joints.
11. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Grooved-End, Copper: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
12. 73 to 168 mm: Aluminum pipe; and roll-groove couplings.
13. NPS 8 (DN 200) and Larger, Grooved: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
14. NPS 8 (DN 200) and Larger, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
15. NPS 8 (DN 200), Grooved-End: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
16. 220 and 274 mm: Aluminum pipe; and roll-groove couplings.

D. Drain Piping: Use[**one of**] the following piping materials:

1. NPS 2 (DN 50) and Smaller: **Type M (Type C)** copper tube; wrought-copper fittings; and brazed or soldered joints.
2. 63 mm and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.

3.2 VALVE APPLICATIONS

A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Article in Section 220523 "General-Duty Valves for Plumbing Piping," according to the following:

1. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
2. High-Pressure Compressed Air: Valve types specified for high-pressure compressed air.
3. Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
4. Grooved-end valves may be used with grooved-end piping and grooved joints.

B. General-Duty Valves for Aluminum Piping System: Provide valves, made by piping system manufacturer, that are compatible with piping.

1. Ball Valves, 63 mm and Smaller: NPT ends, or push-connect bite ring ends.
2. Butterfly Valves, 73 mm and Larger: Tube to tube, with two roll-groove end couplings.

C. Plastic General-Duty Valves: Provide valves, made by piping manufacturer, that are compatible with piping. Do not use plastic valves between air compressors and receivers.

1. Blue ABS Piping System: Ball and butterfly valves.
2. Green ABS Piping System: Ball valves.
3. HDPE Piping System: Ball valves.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless

deviations to layout are approved on Coordination Drawings.

B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Where installing piping adjacent to equipment and machines, allow space for service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
2. Use cast-copper-alloy companion flange with gasket and brazed[**or soldered**] joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, in accordance with Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F2014.

J. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

K. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

L. Install pressure gauge on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220500 "Common Work Results for Plumbing."

M. Install piping to permit valve servicing.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install seismic restraints on piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 INSTALLATION OF ALUMINUM PIPING SYSTEMS

A. Install aluminum piping systems in accordance with manufacturer's written instructions, using manufacturer's recommended tools, accessories, and methods.

B. Install branch connections [**NPS 2-1/2 (DN 65)**][**73 mm**] and larger, to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

C. Install branch connections [**NPS 2 (DN 50)**][**63 mm**] and smaller, to compressed-air mains using aluminum piping system reducing outlet tee with water trapping capabilities. Provide drain leg and drain trap at end of each main and branch and at low points.

D. Support aluminum pipe using manufacturer's hangers and supports, designed for use with the system.

E. Allow for expansion and contraction of aluminum piping system.

F. Do not use plastic components or plastic fittings of any kind within pressurized aluminum piping system. This limitation applies to main headers, branches, and drops.

3.5 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints for Steel Piping: Join in accordance with AWS D10.12/D10.12M.

E. Brazed Joints for Copper Tubing: Join in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Join in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

G. Extruded-Tee Outlets for Copper Tubing: Form branches in accordance with ASTM F2014, with tools recommended by procedure manufacturer, and using operators qualified in accordance with "Quality Assurance" Article.

H. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

I. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join in accordance with AWWA C606 for grooved joints. Do not apply lubricant to prelubricated gaskets.

J. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper

towels. Join in accordance with ASTM D2657 for socket-fusion joints.

K. Press-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified in accordance with "Quality Assurance" Article.

L. Solvent-Cemented Joints for ABS Piping: Clean and dry joining surfaces. Join according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Join in accordance with ASME B31.9 for solvent-cemented joints and with ASTM D2235 Appendix.

M. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.6 INSTALLATION OF VALVES

A. General-Duty Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."

3.7 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 (DN 50) and Smaller: Use dielectric unions.

C. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.8 INSTALLATION OF FLEXIBLE PIPE CONNECTORS

A. Install flexible pipe connectors in discharge piping[**and in inlet air piping from remote air-inlet filter**] of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless steel-hose flexible pipe connectors in steel compressed-air piping.

3.9 INSTALLATION OF SPECIALTIES

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment[**and tools**].

D. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.[**Mount on wall at locations indicated.**]

E. Install air-line lubricators in branch piping to machine tools.[**Mount on wall at locations indicated.**]

F. Install quick couplings at piping terminals for hose connections.

G. Install hose assemblies at hose connections.

3.10 PIPING CONNECTIONS

A. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

B. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.11 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for [**copper tubing**][**and**][**steel piping**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [**ABS**][**HDPE**][**aluminum**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting and coupling.

F. Support vertical runs of [**copper tubing**][**and**][**steel piping**] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of [**ABS**][**HDPE**][**aluminum**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Individual, Straight, Horizontal Piping Runs:

1. 100 Ft. (30 m) or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.

I. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

J. Base of Vertical Piping: MSS Type 52, spring hangers.

K. Install vinyl-coated hangers for [**ABS**][**HDPE**] piping.

3.12 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.13 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of **50 psig (345 kPa)** above system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert pressure**>. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Piping Leak Tests for Aluminum Compressed-Air Piping: Test new piping system and modified parts of existing piping system. Cap and fill general-service compressed-air piping system to pressure of **15 psig (105 kPa)**, hold pressure for 10 minutes. Repeat until reaching required operating pressure, not to exceed **220 psig (1515 kPa)**. Once desired operating pressure is met, let stand for one hour.
3. Piping Leak Tests for ABS Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of **110 deg F (43 deg C)** or less, to pressure of [**40 psig (275 kPa)**]<**Insert pressure**> above system operating pressure, but not less than [**80 psig (550 kPa)**][**100 psig (690 kPa)**]<**Insert pressure**> or more than **120 psig (825 kPa)**. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
4. Piping Leak Tests for HDPE Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of **100 deg F (38 deg C)** or less, to pressure of [**40 psig (275 kPa)**]<**Insert pressure**> above system operating pressure, but not less than [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> or more than **180 psig (1240 kPa)**. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
5. Repair leaks and retest until no leaks exist.
6. Inspect [**filters**][**lubricators**][**and**][**pressure regulators**] for proper operation.

C. Prepare test and inspection reports.

END OF SECTION 22 11 16 00A

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SECTION 22 11 16 00B - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Shape-memory-metal couplings.
3. Corrugated medical tubing (CMT) - copper.
4. Joining materials.
5. Zone valve box assemblies.
6. Ball valves.
7. Check valves.
8. Emergency oxygen connections.
9. Gas safety valves.
10. Pressure regulators.
11. Gas-service connections.
12. Patient-service consoles.
13. Nitrogen pressure-control panels.
14. Ceiling columns.
15. Gas manifolds.
16. Simplex specialty gas manifolds.
17. Duplex specialty gas manifolds.
18. Bulk medical gas storage tanks.
19. Gas cylinder storage racks.

B. Owner-Furnished Material:

1. Patient-service consoles.
2. Ceiling columns.
3. Gas manifolds.
4. Bulk medical gas storage tanks.
5. <**Insert product**>.
6. Owner will furnish gases for [**medical**][**laboratory**] gas concentration testing specified in this Section.

C. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" for building seismic criteria.
2. Section 115313 "Laboratory Fume Hoods" for gas outlets in laboratory fume hoods.
3. Section 123553.13 "Metal Laboratory Casework" for gas outlets in laboratory fume hoods.
4. Section 123553.16 "Plastic-Laminate-Clad Laboratory Casework" for gas outlets in plastic-laminate-clad laboratory casework.
5. Section 123553.19 "Wood Laboratory Casework" for gas outlets in laboratory casework.
6. Section 123570 "Healthcare Casework" for gas outlets in medical casework.
7. Section 220963 "Medical Gas Alarms" for combined medical air, vacuum, and gas alarms.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. D.I.S.S.: Diameter-Index Safety System.

C. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen <**Insert other medical and combination gases**> for healthcare facility patient care.

D. Laboratory gas piping systems include carbon dioxide, helium, nitrogen, nitrous oxide, and oxygen <**Insert other medical and combination gases**> for laboratories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**testing agency**].

B. Seismic Qualification Data: Certificates, for [**gas manifolds**][**and**][**bulk gas storage tanks**], from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Material Certificates: Signed by Installer, certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.

D. Brazing certificates.

E. Field quality control reports.

F. Source Quality Control Reports:

1. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**medical**][**and**][**specialty**] gas piping specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical gas-pressure outlets and suction inlets.

    a. Medical Carbon Dioxide: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    b. Medical Nitrous Oxide: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    c. Medical Oxygen: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    d. <**Insert medical gas**>. Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    e. Laboratory Carbon Dioxide: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    f. Laboratory Nitrous Oxide: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    g. Laboratory Oxygen: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    h. <**Insert laboratory gas**>. Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.

2. D.I.S.S. Service Connections: Furnish complete medical gas pressure outlets and suction inlets complying with CGA V-5.

    a. Medical Carbon Dioxide D.I.S.S. No. 1080: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    b. Medical Helium D.I.S.S. No. 1060: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    c. Medical Nitrogen D.I.S.S. No. 1120: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    d. Medical Nitrous Oxide D.I.S.S. No. 1040: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    e. Medical Oxygen D.I.S.S. No. 1240: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    f. <**Insert medical gas and D.I.S.S. No.**>. Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    g. Laboratory Carbon Dioxide D.I.S.S. No. 1080: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    h. Laboratory Helium D.I.S.S. No. 1060: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    i. Laboratory Nitrogen D.I.S.S. No. 1120: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    j. Laboratory Nitrous Oxide D.I.S.S. No. 1040: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    k. Laboratory Oxygen D.I.S.S. No. 1240: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    l. <**Insert laboratory gas and D.I.S.S. No.**>. Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: In accordance with ASSE Standard #6010[**and NFPA 99**] for medical-gas-system installers.
2. Bulk Medical Gas Systems for Healthcare Facilities: In accordance with ASSE Standard #6015[

and NFPA 99] for bulk-medical-gas-system installers.

3. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is[**a member of the Medical Gas Professional Healthcare Organization or is**] an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel in accordance with ASSE Standard #6020[**and NFPA 99**] for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

C. Brazing: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications," or AWS B2.2/B2.2M.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. [**Medical**][**and**][**laboratory**] carbon dioxide operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

B. [**Medical**][**and**][**laboratory**] helium operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

C. [**Medical**][**and**][**laboratory**] nitrogen operating at [**160 to 185 psig (1100 to 1275 kPa)**][**higher than 200 psig (1380 kPa)**]<**Insert values**>.

D. [**Medical**][**and**][**laboratory**] nitrous oxide operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

E. [**Medical**][**and**][**laboratory**] oxygen operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

F. Specialty <**Insert designation**> operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: [**Gas manifolds**][**and**][**bulk gas storage tanks**] are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the [**gas manifolds**][**and**][**bulk gas storage tanks**] will remain in place without separation of any parts when subjected to the seismic forces specified[**and the manifolds and tanks will be fully operational after the seismic event**]."
2. Component Importance Factor is [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Comply with NFPA 55

C. Comply with NFPA 99.

2.3 PIPES, TUBES, AND FITTINGS

A. For all [**medical**][**and**][**laboratory**] gases, all positive-pressure [**medical**][**and**][**laboratory**] gas piping, tubing, and fittings are to have been manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.

1. Each length of tubing is to be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.
2. Fittings and other components are to be delivered manufacturer sealed and labeled, and kept sealed until prepared for installation.

B. Copper Medical and Laboratory Gas Tube: ASTM B819, [**Type K**][**and**][**Type L**], seamless, drawn temper. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.

D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness, full-face type.
2. Flange Bolts and Nuts: ASME B18.2.1 carbon steel.

F. Shape-Memory-Metal Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aerofit, Inc**]
b. [**CAMERON; A Schlumber Co.**]
c. [**Motion Industries**]
d. [**Smart Tap; Smart Technology, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aerofit, Inc**]
b. [**CAMERON; A Schlumber Co.**]
c. [**Motion Industries**]
d. [**Smart Tap; Smart Technology, Inc.**]
e. <**Insert manufacturer's name**>

3. Description: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy.

G. Corrugated Medical Tubing (CMT) - Copper:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MediTrac; OmegaFlex Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MediTrac; OmegaFlex Inc.**]
b. <**Insert manufacturer's name**>

3. Description: Corrugated medical tubing system including corrugated copper-alloy tubing and brass fittings equipped for direct connection to medical gas piping system components.
4. Standards:

a. UL Through-Penetration Ratings: W-L-1604 and C-AJ-1751.
b. UL Listed: MH64301 UL 1365.
c. Seismically qualified in accordance with ICC-ES AC156; testing protocol in accordance with ICC-ESR-4565.
d. NFPA 99.

5. Quality Certification: Certified to ISO 9001 and 13485:2016 Medical Device Standard.
6. Tubing: ASTM B103/B103M, copper alloy UNS C51000, seamless, corrugated flexible medical tubing.
7. Jacket: Low-density polyethylene.
8. Jacket Flame Spread/Smoke Developed Rating: 25/50, in accordance with ASTM E84.
9. Maximum Operating Pressure, Continuous Use: **185 psig (1275 kPa)**.
10. Test Pressure: **647.4 psig (4464 kPa)**, maximum.
11. Safety Factor: 3.5 times maximum operating pressure, in accordance with NFPA 99.
12. Maximum Operating Temperature, Continuous Use: **250 deg F (121 deg C)**.
13. Maximum Exposure Temperature: **1000 deg F (538 deg C)**, in accordance with NFPA 99.
14. Minimum Bend Radius:

a. **6 inches for 1/2-inch tubing (180 mm for 15-mm tubing)**.
b. **8 inches for 3/4-inch tubing (264 mm for 22-mm tubing)**.
c. **10 inches for 1-inch tubing (336 mm for 28-mm tubing)**.
d. **24 inches for 1-1/2-inch tubing (600 mm for 50-mm tubing)**.

15. Fitting: Brass axial swage fittings, NFPA 99 compliant, and cleaned in accordance with CGA G-4.1, including the following components:

a. Adaptor Material: CA360 brass.
b. Anti-Tamper Sleeve Material: 300 series stainless steel.
c. Non-Removable Threaded Axial Swaging Tool Material: CA360 brass.
d. Split Ring Material: Brass, stainless steel.
e. Jacket Lock Material: CA360 brass.
f. Rear Swage Sleeve Material: CA360 brass.
g. Treaded Driver Material: 300 series stainless steel.

2.4 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.5 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged in accordance with CGA G-4.1 for oxygen service.

B. Zone Valve Box Assemblies: Box with medical gas valves, tube extensions, and gauges.

1. Steel Zone Valve Box with Aluminum Cover:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amico Corporation**]
2) [**BeaconMedaes**]
3) [**CONCOA**]
4) [**Ohio Medical Corporation**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amico Corporation**]
2) [**BeaconMedaes**]
3) [**CONCOA**]
4) [**Ohio Medical Corporation**]
5) <**Insert manufacturer's name**>

c. Description: Formed-steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gauges and in sizes required to permit manual operation of valves.[**Medical air and medical vacuum tubing, valves, and gauges may be incorporated in zone valve boxes for medical gases.**]

1) Interior Finish: Factory-applied white enamel.
2) Cover Plate: Aluminum with frangible or removable windows.
3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, in accordance with NFPA 99.

d. Positive-Pressure Medical Gas Valves, for All Medical Gas Types:

1) Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
2) Delivered sealed and labeled and kept sealed until prepared for installation.

2. Steel Zone Valve Box with Stainless Steel Cover:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amico Corporation**]
2) [**BeaconMedaes**]

3) [**Ohio Medical Corporation**]
4) [**Tri-Tech Medical**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amico Corporation**]
2) [**BeaconMedaes**]
3) [**Ohio Medical Corporation**]
4) [**Tri-Tech Medical**]
5) <**Insert manufacturer's name**>

c. Description: Formed-steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gauges and in sizes required to permit manual operation of valves.[**Medical air and medical vacuum tubing, valves, and gauges may be incorporated in zone valve boxes for medical gases.**]

1) Interior Finish: Factory-applied white enamel.
2) Cover Plate: Stainless steel with frangible or removable windows.
3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, in accordance with NFPA 99.

d. Positive-Pressure Medical Gas Valves, for All Medical Gas Types:

1) Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
2) Delivered sealed and labeled and kept sealed until prepared for installation.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amico Corporation**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**BeaconMedaes**]
d. [**Marwin Valve; Richards Industries**]
e. [**NIBCO INC.**]
f. [**Ohio Medical Corporation**]
g. [**Tri-Tech Medical**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amico Corporation**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**BeaconMedaes**]
d. [**Marwin Valve; Richards Industries**]

e. [**NIBCO INC.**]
f. [**Ohio Medical Corporation**]
g. [**Tri-Tech Medical**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. Description: Three-piece body, brass or bronze.
5. Pressure Rating: **300 psig (2070 kPa)** minimum.
6. Ball: Full-port, chrome-plated brass.
7. Seats: PTFE or TFE.
8. Handle: Lever[**type with locking device**].
9. Stem: Blowout proof with PTFE or TFE seal.
10. Ends: [**Manufacturer-installed ASTM B819, copper-tube extensions**][**and**][**manufacturer-installed ASTM B819, copper-tube extensions with pressure gauge on one copper-tube extension**].
11. Positive-Pressure Medical Gas Valves, for All Medical Gas Types:

    a. Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
    b. Delivered sealed and labeled and kept sealed until prepared for installation.

D. Check Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amico Corporation**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**BeaconMedaes**]
    d. [**Marwin Valve; Richards Industries**]
    e. [**NIBCO INC.**]
    f. [**Ohio Medical Corporation**]
    g. [**Tri-Tech Medical**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Amico Corporation**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**BeaconMedaes**]
    d. [**Marwin Valve; Richards Industries**]
    e. [**NIBCO INC.**]
    f. [**Ohio Medical Corporation**]
    g. [**Tri-Tech Medical**]
    h. <**Insert manufacturer's name**>

3. Description: In-line pattern, bronze.
4. Pressure Rating: **300 psig (2070 kPa)** minimum.
5. Operation: Spring loaded.
6. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
7. Positive-Pressure Medical Gas Valves, for All Gas Types:

a. Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
b. Delivered sealed and labeled and kept sealed until prepared for installation.

E. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amico Corporation**]
b. [**BeaconMedaes**]
c. [**Ohio Medical Corporation**]
d. [**Tri-Tech Medical**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amico Corporation**]
b. [**BeaconMedaes**]
c. [**Ohio Medical Corporation**]
d. [**Tri-Tech Medical**]
e. <**Insert manufacturer's name**>

3. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
4. Inlet: Manufacturer-installed, **NPS 1 or NPS 1-1/4 (DN 25 or DN 32)**, ASTM B819, copper tubing with **NPS 1 (DN 25)** minimum ball valve.
5. Safety Valve: Bronze-body pressure-relief valve set at **75 or 80 psig (520 or 550 kPa)**.
6. Instrumentation: Pressure gauge.
7. Positive-Pressure Medical Gas Valves, for All Medical Gas Types:

a. Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
b. Delivered sealed and labeled and kept sealed until prepared for installation.

F. Gas Safety Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amico Corporation**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**CEODEUX Meditec**]
d. [**UCSF Health Environment of Care**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Amico Corporation**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**CEODEUX Meditec**]
d. [**UCSF Health Environment of Care**]
e. <**Insert manufacturer's name**>

3. Bronze body.
4. ASME-construction, poppet, pressure-relief type.
5. Settings to match system requirements.
6. Positive-Pressure Medical Gas Valves, for All Gas Types:

a. Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
b. Delivered sealed and labeled and kept sealed until prepared for installation.

G. Pressure Regulators:

1. [**Bronze**][**Stainless steel**] body and trim.
2. Spring-loaded, diaphragm-operated, relieving type.
3. Manual pressure-setting adjustment.
4. Rated for [**250-psig (1725-kPa)**]<**Insert value**> minimum inlet pressure.
5. Capable of controlling delivered gas pressure within **0.5 psig for each 10-psig (5.0 kPa for each 100-kPa)** inlet pressure.
6. Positive-Pressure Medical Gas Valves, for All Gas Types:

a. Valves are to be manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
b. Valves are to be delivered sealed and labeled and kept sealed until prepared for installation.

2.6 GAS-SERVICE CONNECTIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amico Corporation**]
2. [**BeaconMedaes**]
3. [**Ohio Medical Corporation**]
4. [**Tri-Tech Medical**]
5. [**Western Enterprises**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Amico Corporation**]
2. [**BeaconMedaes**]
3. [**Ohio Medical Corporation**]
4. [**Tri-Tech Medical**]
5. [**Western Enterprises**]
6. <**Insert manufacturer's name**>

C. General Requirements for Medical and Laboratory Gas-Service Connections:

1. All positive-pressure gas-service connections, for all gas types, are to be manufacturer cleaned, purged, and sealed as for oxygen service in accordance with CGA G-4.1.
2. Suitable for specific gas pressure and suction service listed.
3. Include roughing-in assemblies, finishing assemblies, and cover plates.
4. Recessed-type units made for concealed piping unless otherwise indicated.

D. Roughing-in Assembly:

1. Steel outlet box for recessed mounting and concealed piping.
2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
3. Double seals that will prevent gas leakage.
4. ASTM B819, **NPS 3/8 (DN 10)** copper outlet tube brazed to valve with service marking and tube-end dust cap.

E. Finishing Assembly:

1. Brass housing with primary check valve.
2. Double seals that will prevent gas leakage.
3. Cover plate with gas-service label.

F. Quick-Coupler Pressure Service Connections: Outlets for [**carbon dioxide**][**nitrous oxide**][**and**][**oxygen**]<**Insert type of gas**> with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

G. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

1. Medical Carbon Dioxide: D.I.S.S. No. 1080.
2. Medical Helium: D.I.S.S. No. 1060.
3. Medical Nitrogen: D.I.S.S. No. 1120.
4. Medical Nitrous Oxide: D.I.S.S. No. 1040.
5. Medical Oxygen: D.I.S.S. No. 1240.
6. <**Insert medical gas**>. <**Insert D.I.S.S. No.**>.

H. Cover Plates: One piece, [**aluminum**][**or**][**stainless steel**] and permanent, color-coded, identifying label matching corresponding service.

2.7 PATIENT-SERVICE CONSOLES

A. Patient-Service Consoles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amico Corporation**]
b. [**BeaconMedaes**]
c. [**Tri-Tech Medical**]

d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Amico Corporation**]
   b. [**BeaconMedaes**]
   c. [**Tri-Tech Medical**]
   d. <**Insert manufacturer's name**>

3. Manufacturer cleaned, purged, and sealed, for all medical gas types, for oxygen service in accordance with CGA G-4.1.
4. Standard: UL 60601.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Mounting: [**Recessed**][**Semirecessed**][**Surface**].
7. General Requirements for Patient-Service Consoles: Wall units with service connections. Include labels indicating services as well as the following:

   a. Steel console box or mounting bracket.
   b. Concealed supplies.
   c. Cover: One piece, [**aluminum**][**plastic**][**or**][**stainless steel**] and permanent identifying label.
   d. Medical gas-service connections, as specified in "Gas-Service Connections" Article.

      1) Medical Oxygen: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1240**] pressure outlet(s).
      2) Medical Air: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1160**] quick-coupler pressure outlet(s).
      3) Medical Vacuum: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1220**] suction inlet(s).
      4) Medical Vacuum Bottle Bracket(s): [**One**]<**Insert number**>.

   e. Electrical Service Connections:

      1) General Requirements for Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
      2) Power Outlets: UL 498, Hospital Grade, 125 V ac, [**single**][**duplex**] receptacle(s)[**; in color selected by Architect**]. Include the following configurations in accordance with NEMA WD 1:

         a) [**One**]<**Insert number**> L5-20R, locking type, 20 A, single or duplex.
         b) [**One**]<**Insert number**> L5-20R, isolated ground, locking type, 20 A, single or duplex.
         c) <**Insert outlet type**>.

      3) Electrical Accessory Outlets: Provide the following configured receptacles in color selected by Architect:

         a) Patient Equipment Ground Jack: [**One**]<**Insert number**>, single pole, 30 A.
         b) Patient Monitoring: [**One**]<**Insert number**>, single, [**five**][**and**][**37**]<**Insert number**> pin.
         c) <**Insert outlet type**>.

4) Outlet Cover Plates: One piece, [**aluminum**][**or**][**stainless steel**] and permanent identifying label.

2.8 NITROGEN PRESSURE-CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**Amico Corporation**]
3. [**BeaconMedaes**]
4. [**Ohio Medical Corporation**]
5. [**Tri-Tech Medical**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**Amico Corporation**]
3. [**BeaconMedaes**]
4. [**Ohio Medical Corporation**]
5. [**Tri-Tech Medical**]
6. <**Insert manufacturer's name**>

C. Description: Steel box and support brackets for recessed roughing-in, with stainless steel or anodized-aluminum cover plate with printed operating instructions.

D. Manifold: Assembly consisting of inlet supply valve, inlet supply pressure gauge, line-pressure control regulator, outlet supply pressure gauge, D.I.S.S. service connection, and piping outlet for remote service connection.

E. Minimum Working Pressure: [**200 psig (1380 kPa)**]<**Insert value**>.

F. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.

G. Pressure Gauges: **0 to 300 psig (0 to 2070 kPa)**.

H. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.

I. Before final assembly, provide temporary dust shield and U-tube for testing.

J. Label cover plate "Nitrogen Pressure Control."

K. Manufacturer cleaned, purged, and sealed, for all gas types, for oxygen service in accordance with CGA G-4.1.

2.9 CEILING COLUMNS

A. Ceiling Columns : [**Retractable**][**Stationary**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amico Corporation**]
    b. [**BeaconMedaes**]
    c. [**Ohio Medical Corporation**]
    d. [**Tri-Tech Medical**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Amico Corporation**]
    b. [**BeaconMedaes**]
    c. [**Ohio Medical Corporation**]
    d. [**Tri-Tech Medical**]
    e. <**Insert manufacturer's name**>

3. Description:

    a. Manually adjustable, using release and lock handles capable of locking column in all positions from fully retracted to fully extended; [**15-inch- (380-mm-)**]<**Insert dimension**> long, rectangular, counterbalanced, telescoping section with [**two**][**four**]<**Insert number**> double intravenous medication hooks; and [**36-inch- (915-mm-)**]<**Insert dimension**> long fixed column section. Include **0.078-inch- (2.0-mm-)** thick, stainless steel bottom plate with medical gas and electrical service connections as required.
    b. [**44-inch- (1120-mm-)**]<**Insert dimension**> long, rectangular stationary column section with [**two**][**four**]<**Insert number**> double intravenous medication hooks. Include **0.078-inch- (2.0-mm-)** thick, stainless steel bottom plate with medical gas and electrical service connections as required.
    c. Medical Gas-Service Connections: As specified in "Gas-Service Connections" Article. Include labels indicating services.

        1) Medical Carbon Dioxide: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1080**] pressure outlet(s).
        2) Medical Helium: [**One**]<**Insert number**> D.I.S.S. No. 1060 pressure outlet(s).
        3) Medical Nitrogen: [**One**]<**Insert number**> D.I.S.S. No. 1120 pressure outlet(s).
        4) Medical Nitrous Oxide: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1040**] pressure outlet(s).
        5) Medical Oxygen: [**Two**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1240**] pressure outlets.
        6) Instrument Air: [**One**]<**Insert number**> D.I.S.S. No. 1160 pressure outlet(s).
        7) Medical Air: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1160**] pressure outlet(s).
        8) Medical Vacuum: [**Two**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1220**] suction inlets.
        9) Medical Vacuum Bottle Brackets: [**Two**]<**Insert number**>.
        10) WAGD: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 2220**] suction inlet(s).
        11) <**Insert medical gas**>: <**Insert number and type**>.

    d. Standard: UL 60601.
    e. Manufacturer cleaned, purged, and sealed, for all medical gas type, for oxygen service in accordance with CGA G-4.1.

f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
g. Mounting: Ceiling-mounted units.
h. Ceiling-Mounted Plate: Manufacturer's standard plate or roughing-in assembly.
i. Exposed Surfaces: Minimum **0.0375-inch- (0.95-mm-)** thick stainless steel.
j. Servicing: Include access panels or means of removing shroud.
k. Blank cover plates for cutouts not having service connections.
l. ASTM B819, **NPS 3/8 (DN 10)** copper-tube extensions for connection to medical gas systems.
m. Service Connections: Type and number indicated.
n. Dust Covers: For medical gas-service connections.
o. Electrical Service Connections:

1) Power Outlets: UL 498, Hospital Grade, 125 V ac, [**single**][**duplex**] receptacle(s)[**; in color selected by Architect**]. Include the following configurations in accordance with NEMA WD 1:

a) [**One**][**Two**]<**Insert number**> L5-20R, locking type, 20 A, single or duplex.
b) [**One**][**Two**]<**Insert number**> L5-20R, isolated ground, locking type, 20 A, single or duplex.
c) [**One**][**Two**]<**Insert number**> explosion proof, 20 A, two pole, three wire, single; suitable for Class I, Group C hazardous location and interchangeable with receptacles used in nonhazardous areas; flush mounted.
d) [**One**][**Two**]<**Insert number**> 5-20R, straight blade, 20 A, duplex.
e) [**One**][**Two**]<**Insert number**> 5-20R, isolated ground, straight blade, 20 A, duplex.
f) <**Insert outlet type**>.

2) Electrical Accessory Outlets: Provide the following configured receptacles[**in color selected by Architect**]:

a) Patient Equipment Ground Jack: [**One**]<**Insert number**>, single pole, 30 A.
b) Patient Monitoring: [**One**]<**Insert number**>, single, [**five**][**and**][**37**]<**Insert number**> pin.
c) <**Insert outlet type**>.

3) Outlet Cover Plates: One piece, [**aluminum**][**or**][**stainless steel**] and permanent identifying label.

2.10 GAS MANIFOLDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Cryogenics**]
2. [**Amico Corporation**]
3. [**BeaconMedaes**]
4. [**Ohio Medical Corporation**]
5. [**Tri-Tech Medical**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Cryogenics**]
2. [**Amico Corporation**]
3. [**BeaconMedaes**]
4. [**Ohio Medical Corporation**]
5. [**Tri-Tech Medical**]
6. <**Insert manufacturer's name**>

C. Manufacturer cleaned, purged, and sealed, for all medical gas type, for oxygen service in accordance with CGA G-4.1.

D. Comply with NFPA 99 for high-pressure medical gas cylinders.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Central Control-Panel Unit:

1. Weatherproof cabinet.
2. Supply and delivery pressure gauges.
3. Electrical alarm-system connections and transformer.
4. Indicator lights or devices.
5. Manifold connection.
6. Pressure changeover switch.
7. Line-pressure regulator.
8. Shutoff valves.
9. Safety valve.

G. Manifold and Headers:

1. Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks.
2. Designed for [**2000-psig (13.8-MPa)**]<**Insert value**> minimum inlet pressure, except nitrous oxide manifolds may be designed for [**800 psig (5520 kPa)**]<**Insert value**>, and carbon dioxide manifolds may be designed for [**1500 psig (10.35 MPa)**]<**Insert value**>.
3. Cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1.
4. Individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gauge.

H. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.

I. Mounting: [**Wall with mounting brackets for manifold control cabinet and headers**][**Floor with support legs for manifold control cabinet**].

J. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.

K. Laboratory and Medical Carbon Dioxide Manifolds: For [**two**][**four**]<**Insert number**> cylinders and [**55-psig (380-kPa)**]<**Insert value**> line pressure.

L. Laboratory and Medical Helium Manifolds: For [**two**][**four**]<**Insert number**> cylinders and [**55-psig (380-kPa)**]<**Insert value**> line pressure.

M. Laboratory and Medical Nitrogen Manifolds: For [**eight**][**12**]<**Insert number**> cylinders and [**180-psig (1240-kPa)**][**higher than 200-psig (1380-kPa)**]<**Insert value**> line pressure.

N. Laboratory and Medical Nitrous Oxide Manifolds: For [**eight**][**12**]<**Insert number**> cylinders and [**55-**

psig (380-kPa)]<**Insert value**> line pressure, with electric heater or orifice design that will prevent freezing during high demand.

O. Laboratory and Medical Oxygen Manifolds: For [**12**][**20**]<**Insert number**> cylinders and [**55-psig (380-kPa)**]<**Insert value**> line pressure.

P. Laboratory and Medical Gas Cylinders: [**Furnished by Owner**][**Number and type of medical gas cylinders required for complete manifold systems**]<**Insert requirement**>.

2.11 SIMPLEX SPECIALTY GAS MANIFOLDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Cryogenics**]
2. [**Air Products and Chemicals, Inc.**]
3. [**Airgas; an Air Liquide company**]
4. [**BeaconMedaes**]
5. [**BOC Group, Inc.**]
6. [**CONCOA**]
7. [**GTS-Welco**]
8. [**Linde North America Inc**]
9. [**Matheson Tri-Gas, Inc.**]
10. [**Praxair Technology, Inc.**]
11. [**Spectra Gases, Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Cryogenics**]
2. [**Air Products and Chemicals, Inc.**]
3. [**Airgas; an Air Liquide company**]
4. [**BeaconMedaes**]
5. [**BOC Group, Inc.**]
6. [**CONCOA**]
7. [**GTS-Welco**]
8. [**Linde North America Inc**]
9. [**Matheson Tri-Gas, Inc.**]
10. [**Praxair Technology, Inc.**]
11. [**Spectra Gases, Inc.**]
12. <**Insert manufacturer's name**>

C. Manufacturer cleaned, purged, and sealed, for all medical gas type, for oxygen service in accordance with CGA G-4.1.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gauges, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.

F. Manifold and Header: Nonferrous-metal header for number of cylinders indicated. Units include design for [**2000-psig (13.8-MPa)**]<**Insert value**> minimum inlet pressure, cylinder-bank header with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gauge.

G. Mounting: [**Wall with mounting brackets for manifold control cabinet and header**][**Floor with support legs for manifold control cabinet**].

H. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.

I. Manifold: For <**Insert specialty gas**>; one cylinder and [**55-psig (380-kPa)**]<**Insert value**> line pressure, with electric heater or orifice design that will prevent freezing during high demand.

J. Specialty Gas Cylinders: [**Furnished by Owner**][**Number and type of specialty gas cylinders required for complete manifold systems**]<**Insert requirement**>.

2.12 DUPLEX SPECIALTY GAS MANIFOLDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Cryogenics**]
2. [**Air Liquide America Specialty Gases LLC**]
3. [**Air Products and Chemicals, Inc.**]
4. [**Airgas; an Air Liquide company**]
5. [**BeaconMedaes**]
6. [**BOC Group, Inc.**]
7. [**CONCOA**]
8. [**GTS-Welco**]
9. [**Linde North America Inc**]
10. [**Matheson Tri-Gas, Inc.**]
11. [**Praxair Technology, Inc.**]
12. [**Spectra Gases, Inc.**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Cryogenics**]
2. [**Air Liquide America Specialty Gases LLC**]
3. [**Air Products and Chemicals, Inc.**]
4. [**Airgas; an Air Liquide company**]
5. [**BeaconMedaes**]
6. [**BOC Group, Inc.**]
7. [**CONCOA**]
8. [**GTS-Welco**]
9. [**Linde North America Inc**]
10. [**Matheson Tri-Gas, Inc.**]
11. [**Praxair Technology, Inc.**]
12. [**Spectra Gases, Inc.**]
13. <**Insert manufacturer's name**>

C. Manufacturer cleaned, purged, and sealed, for all gas types, for oxygen service in accordance with CGA

G-4.1.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Central Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gauges, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.

F. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for [**2000-psig (13.8-MPa)**]<**Insert value**> minimum inlet pressure, cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gauge.

G. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.

H. Mounting: [**Wall with mounting brackets for manifold control cabinet and headers**][**Floor with support legs for manifold control cabinet**].

I. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.

J. Manifold: For <**Insert specialty gas**>; two cylinders and [**55-psig (380-kPa)**]<**Insert value**> line pressure, with electric heater or orifice design that will prevent freezing during high demand.

K. Specialty Gas Cylinders: [**Furnished by Owner**][**Number and type of specialty gas cylinders required for complete manifold systems**]<**Insert requirement**>.

2.13 BULK MEDICAL GAS STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Cryogenics**]
2. [**Chart Industries**]
3. [**Taylor-Wharton**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Cryogenics**]
2. [**Chart Industries**]
3. [**Taylor-Wharton**]
4. <**Insert manufacturer's name**>

C. General Requirements for Bulk Medical Gas Storage Tanks:

1. Manufacturer cleaned, purged, and sealed, for all gas types, for oxygen service in accordance with CGA G-4.1.

2. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1; and NFPA 99.
3. Include bulk storage tank with connections for alarm system, continuous supply, and reserve supply that will operate only during emergencies.
4. Controls: Include actuating switch for alarm-system connection and means for automatic actuating of reserve supply.
5. Bulk Gas Storage Tanks: Vertical mounted, double-wall construction with inner vessel fabricated in accordance with ASME Boiler and Pressure Vessel Code for unfired pressure vessels and suitable for gas service. Include insulation and vacuum seal between walls. Fabricate outer shell from carbon steel with factory-applied manufacturer's standard protective paint finish suitable for exterior installation. Include the following features, specialties, and components:

    a. Safety Valves: ASME construction with pressure setting to correspond to tank working pressure and as required for component or system being protected.
    b. Pressure Gauges: For tank pressure and facility service-line pressure.
    c. Contents Gauge: High- and low-level indicator with electric signal circuit connection.
    d. Drain Valves: For piping, inner vessel, and outer shell.
    e. Fill Assembly: Fill connection, piping, valves, relief devices, and controls.
    f. Facility Service Assembly: Piping, valves, relief devices, vaporizer, shutoff valve, pressure regulator, line shutoff valve or check valve, and reserve supply connection for connection to building service piping.
    g. Permanent label showing medical gas type, storage-tank capacity, tank pressure rating, vaporizer capacity, and operating instructions.

D. Liquid Oxygen Storage Tank:

1. Comply with NFPA 55 for bulk oxygen storage tanks.
2. Construction: Nickel-steel or stainless steel inner vessel with [**250-psig (1725-kPa)**]<**Insert value**> minimum working pressure.
3. Vaporizer Type: [**Electric**][**Steam**][**Ambient**].
4. Storage-Tank Capacity: [**As indicated**]<**Insert value**>.
5. Vaporizer Capacity: [**As indicated**]<**Insert value**>.

E. Oxygen Reserve Supply: Manifold header for high-pressure cylinders fabricated from copper-tube or brass pipe and fittings and suitable for pressures of up to [**4000 psig (27.6 MPa)**]<**Insert value**>. Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gauge, and inlet connections for <**Insert number**> cylinders indicated.

F. Liquid Nitrous Oxide Storage Tank:

1. Comply with CGA G-8.1 for bulk nitrous oxide storage tanks.
2. Construction: Steel-alloy inner vessel with [**300-psig (2070-kPa)**]<**Insert value**> minimum working pressure.
3. Vaporizer Type: [**Electric**][**Steam**].
4. Storage Tank Capacity: [**As indicated**]<**Insert value**>.
5. Vaporizer Capacity: [**As indicated**]<**Insert value**>.

G. Nitrous Oxide Reserve Supply: Manifold header for high-pressure cylinders fabricated from copper-tube or brass pipe and fittings and suitable for pressures of up to [**4000 psig (27.6 MPa)**]<**Insert value**>. Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gauge, inlet connections for <**Insert number**> cylinders indicated, and electric heater.

2.14 GAS CYLINDER STORAGE RACKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airgas; an Air Liquide company**]
2. [**RT Racking Systems**]
3. [**USA Safety**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Airgas; an Air Liquide company**]
2. [**RT Racking Systems**]
3. [**USA Safety**]
4. <**Insert manufacturer's name**>

C. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders, as indicated, or provide equivalent manufactured wall racks.

D. Freestanding Storage Racks: Fabricate racks as indicated, or provide equivalent manufactured storage racks.

E. Anchor holes in base to permit securing to the floor with anchor bolts supplied by the manufacturer.

F. Rack Support Tubing: Minimum **2-inch by 2-inch by 1/8-inch (50-mm by 50-mm by 3-mm)** tube steel finished with baked-on exterior grade polyurethane powder paint. All joints wrap-welded and polished.

G. Tank Restraints: Dual minimum **5/16-inch (8-mm)** steel welded link chain, electrically zinc-plated rated for **1900 lb (860 kg)** with minimum **5/16-inch (8-mm)** zinc-plated carabineer hooks rated for minimum **520 lb (235 kg)**.

H. Comply with NFPA 55.

I. Comply with NFPA 99.

J. Comply with OSHPD #OPA-2878-10.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gauges, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service in accordance with CGA G-4.1.
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of **1 lb (0.453 kg)** of chemical to **3 gal. (11.3 L)** of

water.

a. Scrub to ensure complete cleaning.
b. Rinse with clean, hot water to remove cleaning solution.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

3.3 INSTALLATION OF PIPING

A. General Location and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Comply with NFPA 99 for installation of medical gas piping.

C. Comply with NFPA 55 for installation of laboratory gas piping.

D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

G. Install piping adjacent to equipment and specialties to allow service and maintenance.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

I. Install piping to permit valve servicing.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and for branch connections.

L. Install medical gas piping to medical gas-service connections specified in this Section, to medical gas-service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

M. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.

N. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

O. Install medical gas-service connections recessed in walls. Attach roughing-in assembly to substrate;

attach finishing assembly to roughing-in assembly.

P. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

Q. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

U. Prepare tubing and install fittings using tools by product manufacturer.

3.4 INSTALLATION OF VALVES

A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.

F. Install emergency oxygen connection with pressure-relief valve and full-size discharge piping to outside, with check valve downstream from pressure-relief valve, and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.5 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings in accordance with CDA's "Copper Tube Handbook," Ch. "Brazed Joints." Do not use flux. Continuously purge joint with oil-free, dry nitrogen during brazing.

E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube in accordance with procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

F. Soldered Joints: Apply ASTM B813, water-flushable flux to tube end. Join copper tube and fittings in

accordance with ASTM B828.

G. Extruded-Tee Outlets: Form branches in copper tube in accordance with ASTM F2014, with tools recommended by tube manufacturer.

H. Flanged Joints:

1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.
2. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

3.6 INSTALLATION OF GAS-SERVICE COMPONENTS

A. Assemble patient-service console with service connections. Install with supplies concealed in walls. Attach console box or mounting bracket to substrate.

B. Install nitrogen pressure-control panels in walls. Attach to substrate.

C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

D. Assemble ceiling-hose assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

E. Install gas manifolds[**on concrete base**] anchored to substrate.

F. Install gas cylinders and connect to manifold piping.

G. Install gas manifolds with seismic restraints.

H. Install bulk gas storage tanks and reserve supply tanks level on concrete bases. Set tanks and connect gas piping to tanks[**in accordance with applicable requirements in NFPA 55 for bulk oxygen storage systems**]. Install tanks level and plumb, firmly anchored to concrete bases; maintain NFPA 55 and tank manufacturer's recommended clearances. Orient tanks, so controls and devices are accessible for servicing.

I. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Vertical Piping: MSS Type 8 or Type 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52 spring hangers.

G. Install hangers for copper tubing with maximum horizontal spacing and minimum rod diameters to comply with MSS SP-58, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting and coupling.

I. Support vertical runs of copper tubing to comply with MSS SP-58, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for healthcare medical gas piping systems in accordance with NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Carbon Dioxide: Black or white letters on gray background.
2. Helium: White letters on brown background.
3. Nitrogen: White letters on black background.
4. Nitrous Oxide: White letters on blue background.
5. Oxygen: White letters on green background or green letters on white background.

3.9 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of [**medical compressed-air piping**][**and**][**medical vacuum piping**] systems.
2. Preparation: Perform the following Installer tests in accordance with requirements in NFPA 99 and ASSE Standard #6010:

a. Initial blowdown.
b. Initial pressure test.
c. Cross-connection test.
d. Piping purge test.
e. Standing pressure test for positive-pressure medical gas piping.
f. Standing pressure test for vacuum systems.
g. Repair leaks and retest until no leaks exist.

3. System Verification: Perform the following tests and inspections in accordance with NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:

a. Standing pressure test.
b. [**Individual-pressurization**][**or**][**pressure-differential**] cross-connection test.
c. Valve test.
d. Master and area alarm tests.
e. Piping purge test.
f. Piping particulate test.
g. Piping purity test.
h. Final tie-in test.
i. Operational pressure test.
j. Gas concentration test.
k. Air-purity test.
l. Verify correct labeling of equipment and components.
m. Verify medical gas supply sources.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed, and certify report results. Include the following:

a. Inspections performed.
b. Procedures, materials, and gases used.
c. Test methods used.
d. Results of tests.

E. Piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.10 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of **50 psig (345 kPa)** above system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert value**>. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test

pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect specialty gas regulators for proper operation.

E. Piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, in accordance with "Preparation" Article.

3.12 DEMONSTRATION

A. [**Engage factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.13 PIPING SCHEDULE

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Medical Gas Piping except Medical Nitrogen Piping Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

C. Medical Nitrogen Piping Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

D. Specialty Gas Piping except Specialty Gas Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

E. Specialty Gas Piping Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

F. Laboratory Gas Piping except Laboratory Nitrogen Piping NPS 3 (DN 80) and Smaller Operating at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

G. Laboratory Nitrogen Piping NPS 3 (DN 80) and Smaller to Operate at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

H. <**Insert specialty gas**>. Piping except Specialty Gas NPS 3 (DN 80) and Smaller to Operate at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

I. <**Insert specialty gas**>. Piping NPS 3 (DN 80) and Smaller to Operate at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

3.14 VALVE SCHEDULE

A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B819, copper-tube extensions.

B. Zone Valves: Ball valve with manufacturer-installed ASTM B819, copper-tube extensions with pressure gauge on one copper-tube extension.

END OF SECTION 22 11 16 00B

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SECTION 22 11 16 00C - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Stainless steel pipe and fittings.
4. Plastic pipe and fittings.
5. Fiberglass pipe and fittings.
6. Piping joining materials.
7. Transition fittings.
8. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Show hydronic piping layouts, sizes and elevations, including connecting equipment, valves, specialty valves, fittings, strainers, air vents, expansion tanks, air/dirt separators/purgers, meters, expansion loops/expansion joints/anchors, and low point drains.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: [**1/4 inch equals 1 foot (1:50)**] .

C. Delegated Design Submittals:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors, alignment guides, and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

D. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

12. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

13. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

14. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

15. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Welding Certificates: For [**steel support**][**and**][**pipe**] welding.

C. Field Quality Control Reports: For specified tests and inspections.

D. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP are to be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

C. Pipe Welding: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9 for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.5 WARRANTY

A. PP-R and PP-RCT Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.

1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test and any other manufacturer requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. Hot-Water Heating Piping: [**100 psig (689 kPa)**] at [**200 deg F (93 deg C)**][**180 deg F (82 deg C)**].
2. Chilled-Water Piping: [**150 psig (1034 kPa)**] at [**73 deg F (22 deg C)**].
3. Dual-Temperature Heating- and Cooling-Water Piping: [**100 psig (1034 kPa)**] at [**180 deg F (82**

deg C)].
4. Condenser-Water Piping: [150 psig (1034 kPa)] at [73 deg F (66 deg C)].
5. Glycol Cooling-Water Piping: [150 psig (1034 kPa)] at [150 deg F (66 deg C)].
6. Makeup-Water Piping: [80 psig (552 kPa)][150 psig (1034 kPa)] at [73 deg F (22 deg C)][150 deg F (66 deg C)].
7. Condensate-Drain Piping: [150 deg F (66 deg C)][180 deg F (82 deg C)].
8. Air-Vent Piping: [180 deg F (82 deg C)][200 deg F (93 deg C)].
9. Pressure-Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cambridge-Lee Industries, LLC**]
b. [**Cerro Flow Products, LLC**]
c. [**Mueller Streamline Co.; a company of Mueller Industries**]

2. Standard: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**] .

B. Annealed-Temper Copper Tube:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cambridge-Lee Industries, LLC**]
b. [**Cerro Flow Products, LLC**]
c. [**Mueller Streamline Co.; a company of Mueller Industries**]

2. Standard: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**] .

C. DWV Copper Tube: ASTM B306, Type DWV.

D. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

E. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
b. [**Mueller Streamline Co.; a company of Mueller Industries**]
c. [**NIBCO INC.**]

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

G. Cast-Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

H. Wrought-Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

I. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
b. [**T-DRILL Industries Inc**]

2. Description: Tee formed in copper tube in accordance with ASTM F2014.

J. Grooved, Mechanical-Joint, Copper Tube Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**ASC Engineered Solutions**]
c. [**SCI; an ASC Engineered Solution**]
d. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
e. [**Star Pipe Products**]
f. [**Victaulic Company**]

2. Source Limitations: Obtain grooved mechanical-joint copper tube appurtenances from single manufacturer.
3. Grooved-End Copper Fittings: **ASTM B75 (ASTM B75M)** copper tube or ASTM B584 bronze castings.
4. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM gasket rated for minimum [**230 deg F (110 deg C)**] for use with ferrous housing, and steel bolts and nuts; **300 psig (2060 kPa)** minimum CWP pressure rating.

K. Copper-Tube, Pressure-Seal-Joint Fittings - Copper or Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
b. [**Copper Press Brand; Merit Brass Company**]
c. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Mueller Streamline Co.; a company of Mueller Industries**]
f. [**NIBCO INC.**]
g. [**Victaulic Company**]
h. [**Viega LLC**]

2. Source Limitations: Obtain copper-tube pressure-seal-joint fittings from single manufacturer.
3. Housing: Copper or bronze.
4. O-Rings and Pipe Stops: EPDM.
5. Tools: Manufacturer's special tools.
6. Minimum **200 psig (1370 kPa)** working pressure rating at **250 deg F (121 deg C)**.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M black steel with plain ends; welded and seamless, Grade B, and schedule number as indicated in Part 3,"Hydronic Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3, "Hydronic Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3, "Hydronic Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3, "Hydronic Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Hydronic Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A234/A234M; wall thickness to match adjoining pipe.

G. Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**ASC Engineered Solutions**]
d. [**GroovJoint**]
e. [**National Fittings, Inc**]
f. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]

g. [**SCI; an ASC Engineered Solution**]
h. [**Star Pipe Products**]
i. [**Victaulic Company**]

2. Source Limitations: Obtain grooved mechanical-joint fittings and couplings from single manufacturer.
3. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
4. Couplings: Ductile- or malleable-iron housing and [**EPDM**][**nitrile**] gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Plain-End Mechanical-Joint Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**NormaGroup**]
c. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
d. [**Victaulic Company**]

2. Source Limitations: Obtain plain-end mechanical-joint couplings from single manufacturer.
3. Housing: ASTM A536, Grade 65-45-12 segmented ductile iron or Type 304 stainless steel.
4. Housing coating: [**None**].
5. Gasket: [**EPDM**][**NBR**] .
6. Sealing Mechanism: Double-lip sealing system or carbon steel case-hardened jaws.
7. Bolts, hex nuts, washers, or lock bars based on manufacturer's design.
8. Minimum Pressure Rating: Equal to that of the joined pipes.

J. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless Steel Pipe, Plain Ends: ASTM A312/A312M plain ends, seamless; stainless steel of types and schedules as indicated in Part 3 "Hydronic Piping Applications" Article.

B. Appurtenances for Grooved-End, Stainless Steel Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**ASC Engineered Solutions**]
c. [**National Fittings, Inc**]
d. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]

e. [**SCI; an ASC Engineered Solution**]
f. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
g. [**Star Pipe Products**]
h. [**Victaulic Company**]

2. Source Limitations: Obtain appurtenances for grooved-end stainless steel pipe from single manufacturer.
3. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.

4. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:

a. AWWA C606 for stainless steel pipe dimensions.
b. Stainless steel housing sections.
c. Stainless steel bolts and nuts.
d. EPDM gaskets suitable for hot and cold water.
e. Minimum Pressure Rating:

1) NPS 8 (DN 200) and Smaller: [**600 psig (4137 kPa)**].
2) NPS 10 to NPS 12 (DN 250 to DN 300): [**400 psig (2758 kPa)**].
3) NPS 14 to NPS 24 (DN 350 to DN 600): [**250 psig (1725 kPa)**].

C. Stainless Steel Piping, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**GroovJoint**]
c. [**Merit Brass Company**]
d. [**SCI; an ASC Engineered Solution**]
e. [**Victaulic Company**]
f. [**Viega LLC**]

2. Source Limitations: Obtain stainless steel piping pressure-seal-joint fittings from single manufacturer.
3. Material: ASTM A312/A312M, Type 316, stainless steel, Schedule 10.
4. Fittings: Type O-Rings and Pipe Stop: EPDM.
5. Tools: Manufacturer's special tool.
6. Minimum **300 psig (2070 kPa)** working-pressure rating at **230 deg F (110 deg C)**.

2.5 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F441/F441M, with wall thickness as indicated in "Hydronic Piping Applications" Article.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**IPEX USA LLC**]
c. [**Spears Manufacturing Company**]
d. [**Uponor Inc.**]

2. Source Limitations: Obtain CPVC plastic pipe from single manufacturer.

3. CPVC Socket Fittings: [**ASTM F438 for Schedule 40**][**and**][**ASTM F439 for Schedule 80**] .

4. CPVC Threaded Fittings: ASTM F437, Schedule 80.

5. CPVC Piping System: ASTM D2846/D2846M, SDR, pipe and socket fittings.

6. CPVC Tubing System: ASTM D2846/D2846M, SDR, tube and socket fittings.

B. PVC Plastic Pipe: ASTM D1785, with wall thickness as indicated in "Hydronic Piping Applications" Article.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**IPEX USA LLC**]
c. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain PVC plastic pipe from single manufacturer.

3. PVC Socket Fittings: [**ASTM D2466 for Schedule 40**][**and**][**ASTM D2467 for Schedule 80**] .

4. PVC Schedule 80 Threaded Fittings: ASTM D2464.

C. Polypropylene (PP-R and PP-RCT) Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**aquatherm**]
b. [**Asahi/America**]
c. [**IPEX USA LLC**]
d. [**Nupi Americas**]
e. [**Uponor Inc.**]

2. Source Limitations: Obtain polypropylene (PP-R and PP-RCT) pipe from single manufacturer.
3. Description: ASTM F2389; pipe pressure rating to comply with temperature and pressure ratings of code requirements for the applicable service.

a. Polypropylene Fittings: ASTM F2389, socket fusion, butt fusion, electrofusion, or fusion outlet fittings to be used for fusion-welded joints between pipe and fittings.
b. Mechanical fittings and transition fittings to be used where transitions are made to other

piping materials or to valves and appurtenances.

c. Polypropylene pipe is to be unthreaded. Threaded transition fittings in accordance with ASTM F2389 to be used where a threaded connection is required.

D. Smoke and Fire Ratings:

1. Where indicated on Drawings that a plenum-rated piping system is required, the pipe is to be wrapped and/or insulated with fiberglass or mineral wool pipe insulation; field installed.

a. The system is to have a flame-spread classification of less than 25 and smoke-developed rating of less than 50.
b. Pipe, wrap, or insulation as a system to comply with the requirements of CAN/ULC-S102.2, ASTM E84, or UL 2846.
c. For insulation required for thermal and condensation conditions, see Section 230719 "HVAC Piping Insulation."

2.6 FIBERGLASS PIPE AND FITTINGS

A. RTRP: ASTM D2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.

B. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.

C. Flanges: ASTM D4024; full-face gaskets suitable for the service, minimum **1/8-inch (3.2-mm)** thick, 60-70 durometer. Provide ASTM A307, Grade B, hex head bolts with washers.

2.7 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Flux: ASTM B813, water flushable.

G. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for CPVC Piping: ASTM F493.

1. Product Data: Verify CPVC welding solvent cement has a VOC content of 490 g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

I. Solvent Cements for PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

1. Product Data:

   a. Verify PVC welding solvent cement has a VOC content of 510 g/L or less.
   b. Verify adhesive primer has a VOC content of 550 g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

6. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

7. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

8. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended

exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

J. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

1. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

2.8 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**IPEX USA LLC**]
c. [**Uponor Inc.**]
d. [**Viega LLC**]

2. Source Limitations: Obtain plastic-to-metal transition fittings from single manufacturer.
3. Description: [**CPVC**][**PVC**] one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.

a. End Connections: One end with threaded brass insert and one solvent-cement-socket [**or threaded**] end.

4. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

D. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**aquatherm**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**IPEX USA LLC**]
   d. [**NIBCO INC.**]
   e. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain plastic-to-metal transition unions from single manufacturer.
3. Brass or copper end and solvent-cement-joint end of union to match pipe in size and material.
4. Description: [**CPVC**][**PVC**] four-part union.

   a. Threaded End: Brass [**or stainless steel**] .
   b. End Connections: Solvent-cement-joint [**or threaded**] plastic end.
   c. Gasket: Rubber O-ring.
   d. Union nut.

2.9 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Capitol Manufacturing Company**]
   c. [**GF Piping Systems**]
   d. [**HART Industrial Unions, LLC**]
   e. [**Jomar Valve**]
   f. [**Matco-Norca**]
   g. [**WATTS; A Watts Water Technologies Company**]
   h. [**Wilkins**]
   i. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain dielectric unions from single manufacturer.
3. Standard: ASSE 1079.

4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].
5. End Connections: Solder-joint copper alloy and threaded ferrous. Solder joints are not to be used

on pipe sizes greater than NPS 4 (DN 100).

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASC Engineered Solutions**]
   b. [**GF Piping Systems**]
   c. [**WATTS; A Watts Water Technologies Company**]
   d. [**Wilkins**]
   e. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain dielectric flanges from single manufacturer.
3. Standard: ASSE 1079.
4. Description: Factory-fabricated, bolted, companion-flange assembly.
5. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**].
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GF Piping Systems**]
   d. [**GPT Industries, LLC.**]

2. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
3. Description: Nonconducting materials for field assembly of companion flanges.
4. Pressure Rating: [**150 psig (1035 kPa)**].
5. Gasket: Neoprene or phenolic.
6. Bolt Sleeves: Phenolic or polyethylene.
7. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]

c. [**Elster Perfection; Honeywell**]
d. [**GPT Industries, LLC.**]
e. [**Matco-Norca**]
f. [**Precision Plumbing Products**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**Victaulic Company**]

2. Source Limitations: Obtain dielectric nipples from single manufacturer.
3. Standard: IAPMO PS 66.
4. Description: Electroplated steel nipple, complying with ASTM F1545.

5. Pressure Rating: Minimum [**300 psig (2070 kPa) at 225 deg F (107 deg C)**].
6. End Connections: Male threaded or grooved.
7. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 HYDRONIC PIPING APPLICATIONS

A. Hot-Water Heating Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**], wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250, cast-iron**][**Class 300, malleable-iron**] fittings; and [**threaded**][**grooved mechanical**] joints.
3. Stainless Steel Pipe, Plain Ends:

    a. Schedule 5, [**Type 304**]; [**Type 316**]; stainless steel pressure-seal fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive joints.

B. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**grooved mechanical**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; fittings and joints as follows:

    a. [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250 cast-iron**][**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges, flange-fittings, and flanged joints.
    b. Grooved mechanical joint coupling and fittings; and grooved mechanical joints.
    c. Plain-end mechanical joint couplings and fittings; and plain-end mechanical joints.

3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

C. Chilled-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to be Any of the Following:

1. Drawn-Temper Copper Tube: [Type K (Type A)][Type L (Type B)]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250, cast-iron**][**Class 300, malleable-iron**] fittings; and [**threaded**][**grooved mechanical**] joints.
3. Stainless Steel Pipe, Plain Ends:

    a. Schedule 5, [**Type 304**]; [**Type 316**]; stainless steel pressure-seal fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
6. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

D. Chilled-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [Type K (Type A)][Type L (Type B)]; wrought-copper fittings; and [**soldered**][**brazed**][**grooved mechanical**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings; and welded and flanged joints**][**grooved mechanical joint coupling and fittings; and grooved mechanical joints**][**plain-end mechanical joint coupling and fittings; and plain-end mechanical joints**] .
3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved, mechanical joints.
4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.
6. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.

E. Dual-Temperature Heating- and Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [Type K (Type A)][Type L (Type B)]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250, cast-iron**][**Class 300, malleable-iron**] fittings; and [**threaded**][**grooved mechanical**] joints.
3. Stainless Steel Pipe, Plain Ends:

    a. Schedule 5, [**Type 304**]; [**Type 316**] stainless steel pressure-seal couplings and fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
6. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

F. Dual-Temperature Heating and Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [Type K (Type A)][Type L (Type B)]; wrought-copper fittings; and

[**soldered**][**brazed**][**grooved mechanical**] joints.

2. Steel Pipe: [**Schedule 40**], Grade B; fittings and joints as follows:

    a. [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250 cast-iron**][**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
    b. Grooved mechanical joint coupling and fittings; and grooved mechanical joints.
    c. Plain-end mechanical joint couplings and fittings; and plain-end mechanical joints.

3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

G. Condenser-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**], drawn-temper copper tubing, wrought-copper fittings, and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B, steel pipe; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250 cast-iron**][**Class 300 malleable-iron**] , fittings; and [**threaded**][**grooved mechanical**] joints.
3. Stainless Steel Pipe, Plain Ends:

    a. Schedule 5, [**Type 304**]; [**Type 316**], stainless steel pressure-seal couplings and fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
6. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive joints.

H. Condenser-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**grooved mechanical**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; fittings and joints as follows:

    a. [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250 cast-iron**][**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
    b. Grooved, mechanical joint coupling and fittings; and grooved mechanical joints.
    c. Plain-end mechanical joint coupling and fittings; and plain-end mechanical joints.

3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.
6. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] piping and fittings with heat fusion joints.

I. Glycol Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [Type K (Type A)][Type L (Type B)]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**]; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250, cast-iron**][**Class 300, malleable-iron**] fittings; and threaded joints.
3. Stainless Steel Pipe, Plain Ends:

    a. Schedule 5, [**Type 304**]; [**Type 316**], stainless steel pressure-seal couplings and fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**], CPVC plastic pipe and fittings and solvent-welded joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
6. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

J. Glycol Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [Type K (Type A)][Type L (Type B)]; wrought-copper fittings; and [**soldered**][**brazed**][**grooved mechanical**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings; and welded and flanged joints**][**grooved, mechanical joint coupling and fittings; and grooved mechanical joints**][**plain-end mechanical joint coupling and fittings; and plain-end mechanical joints**] .
3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.
4. CPVC Plastic Pipe.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.
6. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.

K. Makeup-Water Piping Installed Aboveground to Be Any of the Following:

1. Drawn-Temper Copper Tube: [Type K (Type A)][Type L (Type B)]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**mechanical grooved**][**mechanically formed tee**] joints.
2. Stainless Steel Pipe:

    a. Schedule 5, [**Type 304**]; [**Type 316**], stainless steel pressure-seal couplings and fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

3. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
4. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive joints.

L. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:

1. Drawn-Temper Copper Tube: [Type K (Type A)][Type L (Type B)][**Type DWV**]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Stainless Steel Pipe, Plain Ends: Schedule 5, [**Type 304**]; [**Type 316**], stainless steel pressure-seal couplings and fittings; and pressure-seal joints.

3. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
4. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.

M. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems, in accordance with piping manufacturer's written instructions.
2. Outlet: **Type K (Type A)**, annealed-temper copper tubing with soldered or flared joints.

N. Pressure-Relief-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems, in accordance with piping manufacturer's written instructions.

3.2 INSTALLATION OF HYDRONIC PIPING

A. Requirements in this article apply to all piping materials, except where more specific requirements are specified in various pipe and fittings installation articles below.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install drains, consisting of a tee fitting, **NPS 3/4 (DN 20)** ball valve, and short **NPS 3/4 (DN 20)** threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

N. Install hydronic closed-loop piping at a uniform grade of 0.2 percent upward in direction of flow.

O. Install cooling coil condensate-drain piping at a minimum one percent downward slope, **1/8 inch per foot (10.4 mm per m)** horizontal run or as required by code whichever is more stringent.

P. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

Q. Install branch connections to mains using [**mechanically formed**] tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

R. Install valves in accordance with Section 230523 "General-Duty Valves for HVAC Piping."

S. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."

T. Install unions in piping, [**NPS 2 (DN 50)**] and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

U. Install flanges in piping, [**NPS 2-1/2 (DN 65)**] and larger, at final connections of equipment and elsewhere as indicated.

V. Install shutoff valve immediately upstream of each dielectric fitting.

W. Comply with requirements in Section 230500 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

X. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

Y. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

Z. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

AA. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

BB. Joint Construction, General:

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3.3 INSTALLATION OF COPPER TUBE AND FITTINGS

A. Joint Construction:

1. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
2. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

3. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves

in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings

4. Mechanically Formed Tee Fittings: Use manufacturer-recommended tools, procedure, and brazed joints.

5. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF STEEL PIPE AND FITTINGS

A. Joint Construction:

1. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

2. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.
3. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

4. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings

5. Plain-End Mechanical-Coupled Joints: Prepare, assemble, and test joints in accordance with manufacturer's written installation instructions

3.5 INSTALLATION OF STAINLESS STEEL PIPE AND FITTINGS

A. Joint Construction:

1. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

2. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.6 INSTALLATION OF PLASTIC PIPE AND FITTINGS

A. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.

3. PVC Pressure Piping: Join ASTM D1785 schedule number, PVC pipe, and PVC socket fittings in accordance with ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings in accordance with ASTM D2855.
4. PVC Nonpressure Piping: Join in accordance with ASTM D2855.

3.7 INSTALLATION OF FIBERGLASS PIPE AND FITTINGS

A. Joint Construction:

1. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
2. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join in accordance with pipe manufacturer's written instructions.

3.8 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

1. Dielectric Unions: For [**NPS 2 (DN 50) and smaller**][**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**] .
2. Dielectric Flanges: For **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**.
3. Dielectric-Flange Insulating Kits: For [**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**][**NPS 5 (DN 125) and larger**] .

3.9 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Metal Tube or Pipe:

1. Install hangers for with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of metal tube or pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Plastic Pipe:

1. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of plastic piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Fiberglass Pipe:

1. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and

authorities having jurisdiction requirements, whichever are most stringent.

2. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within [**12 inches (300 mm)**] of each fitting and coupling.

3.10 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections are to be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230500 "Common Work Results for HVAC."

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.12 SYSTEM STARTUP

A. System Startup Preparation: Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.13 FIELD QUALITY CONTROL

A. Test Preparation: Prepare hydronic piping in accordance with ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure is to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install pressure-relief valve, set at a pressure no more than one-third higher than test pressure, to

protect against damage by expanding liquid or other source of overpressure during test.

B. Piping Tests: Perform the following tests on hydronic piping:

1. Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

END OF SECTION 22 11 16 00C

SECTION 22 11 16 00D - STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. Stainless steel pipe and fittings.
3. Fiberglass pipe and fittings.
4. Joining materials.

B. Related Requirements:

1. Section 232216 "Steam and Condensate Heating Piping Specialties" for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show steam and steam condensate piping layouts, sizes, elevations, and piping slopes, including connecting equipment, valves, special-duty valves, fittings, strainers, air vents and vacuum breakers, flash tanks, steam pressure reducing valves, steam traps, steam meters, steam condensate meters, and expansion loops/expansion joints/anchors.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: [**1/4 inch equals 1 foot (1:50)**]<**Insert value**>.

C. Sustainable Design Submittals:

1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.

D. Delegated Design Submittals:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the

same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fiberglass Pipe and Fitting Installers: Installers of fiberglass pipe and fittings to be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators in accordance with the following:

1. ASME Compliance: Comply with [**ASME B31.1, "Power Piping,"**][**and**][**ASME B31.9, "Building Services Piping,"**] for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. HP Steam Piping: <**Insert psig (kPa)**>.
2. LP Steam Piping: <**Insert psig (kPa)**>.
3. LP Clean Steam Piping: <**Insert psig (kPa)**>.

4. Condensate Piping: <**Insert psig (kPa)**> at [**250 deg F (121 deg C)**]<**Insert temperature**>.
5. Clean Steam Condensate Piping: <**Insert psig (kPa)**> at [**250 deg F (121 deg C)**]<**Insert temperature**>.
6. Makeup-Water Piping: [**80 psig (552 kPa)**][**150 psig (1034 kPa)**]<**Insert value**> at [**150 deg F (66 deg C)**]<**Insert temperature**>.
7. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
8. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
9. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.3 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless Steel Pipe: ASTM A312/A312M, plain ends, seamless; stainless steel of types and schedules as indicated in piping application articles.

B. Stainless Steel Socket Weld Fittings: Stainless steel, wrought or forged, of types and classes as indicated in piping application articles.

C. Stainless Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, wrought, raised face weld neck, including gaskets, bolts, and nuts of material to match pipe.

2.4 FIBERGLASS PIPE AND FITTINGS

A. Reinforced Thermosetting Resin Pressure Pipe (RTRP): ASTM D2996, Type 1, Grade 1, Class F, filament-wound pipe with tapered bell and spigot ends for adhesive joints.

B. Glass-Fiber-Reinforced Thermosetting-Resin: ASTM D5685, Type 2 or Type 5, Grade 1, Class F, compression or spray-up/contact molded fittings of same material, pressure class, and joining method as pipe.

C. Flanges: ASTM D4024, Type 1, Grade 1, full-face gaskets suitable for the service, minimum **1/8 inch (3.2 mm)** thick, 60-70 durometer. ASTM A307, Grade B, hex head bolts with washers.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face flanges.
b. Narrow-Face Type: For raised-face flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel of type to match pipe unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

E. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

1. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, [**NPS 2 (DN 50) and Smaller**]<**Insert pipe size range**>: [**Schedule 40**][**Schedule 80**], Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, [**NPS 2-1/2 through NPS 12 (DN 65 through DN 300)**]<**Insert pipe size range**>: [**Schedule 40**][**Schedule 80**], Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. LP Steam Piping, [**NPS 14 through NPS 18 (DN 350 through DN 450)**]<**Insert pipe size range**>: Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

D. LP Steam Piping, [**NPS 20 (DN 500) and Larger**]<**Insert pipe size range**>: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping above grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be[**either of**] the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

F. Condensate piping above grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be[**either of**] the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

G. Condensate piping below grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be[**either of**] the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

H. Condensate piping below grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be[**either of**] the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

I. LP Clean Steam Piping:

1. LP clean steam piping above grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be the following:

a. [**Schedule 40**][**Schedule 80**], [**Type 304**][**Type 316**] stainless steel pipe; [**wrought**][**or**][**forged**], [**Class 2000**][**Class 3000**]<**Insert class**>, same type stainless steel socket weld fittings.

2. LP clean steam piping above grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be the following:

    a. [**Schedule 40**][**Schedule 80**], [**Type 304**][**Type 316**] stainless steel pipe; same type stainless steel flanges and wrought stainless steel flanged fittings.

J. Clean Steam Condensate Piping:

1. Clean steam condensate piping above grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be the following:

    a. [**Schedule 40**][**Schedule 80**], [**Type 304**][**Type 316**] stainless steel pipe; [**wrought**][**or**][**forged**][**Class 2000**][**Class 3000**]<**Insert class**> same type stainless steel socket weld fittings.

2. Clean steam condensate piping above grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be the following:

    a. [**Schedule 40**][**Schedule 80**], [**Type 304**][**Type 316**] stainless steel pipe; same type stainless steel flanges and wrought stainless steel flanged fittings.

3.2 HP STEAM PIPING APPLICATIONS

A. HP Steam Piping, [**NPS 2 (DN 50) and Smaller**]<**Insert pipe size range**>: [**Schedule 40**][**Schedule 80**], Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. HP Steam Piping, [**NPS 2-1/2 through NPS 12 (DN 65 through DN 300)**]<**Insert pipe size range**>: [**Schedule 40**][**Schedule 80**], Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. HP Steam Piping, [**NPS 14 through NPS 18 (DN 350 through DN 450)**]<**Insert pipe size range**>: Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

D. HP Steam Piping, [**NPS 20 (DN 500) and Larger**]<**Insert pipe size range**>: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping above grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be[**either of**] the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

F. Condensate piping above grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be[**either of**] the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

G. Condensate piping below grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be[**either of**] the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

H. Condensate piping below grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be[**either of**] the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

3.3 ANCILLARY PIPING APPLICATIONS

A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

B. Vacuum-Breaker Piping: Outlet, same as service where installed.

C. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, **NPS 3/4 (DN 20)** full port-ball valve, and short **NPS 3/4 (DN 20)** threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using[**mechanically formed**] tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves in accordance with Section 230523 "General-Duty Valves for HVAC Piping" or other Sections as needed.

Q. Install unions in piping, [**NPS 2 (DN 50)**]<**Insert pipe size**> and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size**> and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install **NPS 3/4 (DN 20)** nipple and full port ball valve in blowdown connection of strainers **NPS 2 (DN 50)** and larger. Match size of strainer blowoff connection for strainers smaller than **NPS 2 (DN 50)**.

U. Comply with requirements in Section 230500 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

W. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding [**300 ft. (90 m)**]<**Insert distance**>.
2. Size drip legs same size as main. In steam mains **NPS 6 (DN 150)** and larger, drip leg size can be reduced, but to no less than **NPS 4 (DN 100)**.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.5 INSTALLATION OF STEAM AND CONDENSATE PIPING SPECIALTIES

A. Comply with requirements in Section 232216 "Steam and Condensate Heating Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers, supports, and anchor devices.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than **20 ft.** **(6 m)** long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping **20 ft.** **(6 m)** or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft.** **(6 m)** or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

D. Install hangers for steel steam supply piping and steel steam condensate piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within [**12 inches** **(300 mm)**]<**Insert dimension**> of each fitting.

G. Support vertical runs of steel steam supply piping and steel steam condensate piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join in accordance with pipe manufacturer's written instructions.

3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections to be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.9 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping in accordance with [**ASME B31.1, "Power Piping,"**][**and**][**ASME B31.9, "Building Services Piping,"**] and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure will not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

E. Prepare test and inspection reports.

END OF SECTION 22 11 16 00D

SECTION 22 11 16 00E - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Valves and specialties.
4. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

B. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, at a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: [**1/4 inch equals 1 ft. (1:50)**]<**Insert value**> .

C. Delegated Design Submittals: For refrigerant piping design, including sizing and layout, oil traps, double risers, specialties, and pipe and tube sizes to accommodate, at a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Sustainable Design Submittals:

1. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
2. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Provide plans, piping schematics, and details, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Welding Certificates: For each welder performing shop or field welding on Project.

C. Field Quality Control Reports: For each specified field quality-control test and inspection.

D. Delegated Design Engineer Qualification Statement: For refrigerant piping design.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

B. Prepare valves and specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads and other end connections.

C. Use precautions during storage as follows:

1. Maintain valve and specialty end protection.
2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

B. Comply with ASHRAE 15 and ASHRAE 34.

C. Comply with ASME B31.5.

D. Test Pressure for Refrigerant R-32:

1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: [**300 psig (2068 kPa)**]<**Insert pressure**> .
2. Suction Tubing for Heat-Pump Applications: [**535 psig (3689 kPa)**]<**Insert pressure**> .
3. Hot-Gas and Liquid Tubing: [**535 psig (3689 kPa)**]<**Insert pressure**> .

E. Test Pressure for Refrigerant R-454B:

1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: [**300 psig (2068 kPa)**]<**Insert pressure**> .
2. Suction Tubing for Heat-Pump Applications: [**535 psig (3689 kPa)**]<**Insert pressure**> .
3. Hot-Gas and Liquid Tubing: [**535 psig (3689 kPa)**]<**Insert pressure**> .

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube, for Refrigerant Piping: [**ASTM B280, Type ACR,**][**drawn-temper**][**and**][**annealed-temper**]<**Insert ASTM standard and type**> .

B. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8M/A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum **3/4-inch (20-mm)** misalignment in minimum **7-inch-(180-mm-)** long assembly.
4. Working Pressure Rating: Factory test at minimum [**500 psig (3450 kPa)**]<**Insert pressure rating**> .
5. Maximum Operating Temperature: [**250 deg F (121 deg C)**]<**Insert temperature**> .

F. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Conex Bänninger; a part of IBP Group LLC**]
    b. [**Mueller Streamline Co.; a company of Mueller Industries**]
    c. [**Parker Hannifin; Sporlan Division**]
    d. [**RLS LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Conex Bänninger; a part of IBP Group LLC**]
    b. [**Mueller Streamline Co.; a company of Mueller Industries**]
    c. [**Parker Hannifin; Sporlan Division**]
    d. [**RLS LLC**]
    e. <**Insert manufacturer's name**>

3. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
4. Housing: Copper.
5. O-Rings: [**HNBR**]<**Insert material type**> compatible with specific refrigerant.
6. Tools: Manufacturer's approved special tools.
7. Minimum Rated Pressure: [**700 psig (48 bar)**]<**Insert pressure**> .

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; type, grade, and pipe schedule as selected in "Piping Application Schedules" Article.

B. Wrought-Steel Fittings: ASTM A234/A234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5 steel, including bolts, nuts, gaskets, bevel-welded end connection, and raised face.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 and ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Flanged Unions:

1. Body: Forged-steel flanges for **NPS 1 to NPS 1-1/2 (DN 25 to DN 40)** and ductile iron for **NPS 2 to NPS 3 (DN 50 to DN 80)**. Factory apply rust-resistant finish.
2. Gasket: Fiber asbestos free.
3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Factory apply rust-resistant finish.
4. Offset Performance: Capable of minimum **3/4-inch (20-mm)** misalignment in minimum **7-inch-(180-mm-)** long assembly.
5. Pressure Rating: Factory test at minimum [**400 psig (2760 kPa)**]<**Insert pressure**> .
6. Maximum Operating Temperature: **330 deg F (165 deg C)**.

F. Flexible Connectors:

1. Body: Stainless steel bellows with woven, flexible, stainless steel-wire-reinforced protective jacket.
2. End Connections:

a. NPS 2 (DN 50) and Smaller: With threaded-end connections.
b. NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.

3. Offset Performance: Capable of minimum **3/4-inch (20-mm)** misalignment in minimum **7-inch-(180-mm-)** long assembly.
4. Pressure Rating: Factory test at minimum [**500 psig (3450 kPa)**]<**Insert pressure**> .
5. Maximum Operating Temperature: [**250 deg F (121 deg C)**]<**Insert temperature**> .

2.4 Copper-Tube, Solder Fittings for Refrigerant

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.5 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
4. Diaphragm: Phosphor bronze and stainless steel with stainless steel spring.
5. Operator: Rising stem and hand wheel.
6. Seat: Nylon.
7. End Connections: Socket, union, or flanged.
8. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
9. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

B. Packed-Angle Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body and Bonnet: Forged brass or cast bronze.
4. Packing: Molded stem, back seating, and replaceable under pressure.
5. Operator: Rising stem.
6. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
7. Seal Cap: Forged-brass or valox hex cap.
8. End Connections: Socket, union, threaded, or flanged.
9. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
10. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Danfoss, Inc.**]
    c. [**Henry Technologies Inc.; The Henry Group**]
    d. [**Parker (Parker Hannifin)**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Danfoss, Inc.**]
    c. [**Henry Technologies Inc.; The Henry Group**]
    d. [**Parker (Parker Hannifin)**]
    e. <**Insert manufacturer's name**>

3. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
4. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
5. Piston: Removable polytetrafluoroethylene seat.
6. Closing Spring: Stainless steel.
7. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
8. End Connections: Socket, union, threaded, or flanged.
9. Maximum Opening Pressure: **0.50 psig (3.4 kPa)**.
10. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
11. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**JB Industries**]
    d. [**Parker (Parker Hannifin)**]
    e. [**RectorSeal HVAC; a CSW Industrials Company**]
    f. [**Refrigeration Sales, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**JB Industries**]
    d. [**Parker (Parker Hannifin)**]
    e. [**RectorSeal HVAC; a CSW Industrials Company**]

f. [**Refrigeration Sales, Inc.**]
g. <**Insert manufacturer's name**>

3. Body: Forged brass with brass cap, including key end to remove core.
4. Core: Removable ball-type check valve with stainless steel spring.
5. Seat: Polytetrafluoroethylene.
6. End Connections: Copper spring.
7. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
8. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

E. Refrigerant Locking Caps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**C & D Valve, LLC**]
b. [**JB Industries**]
c. [**RectorSeal HVAC; a CSW Industrials Company**]
d. [**Refrigeration Sales, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**C & D Valve, LLC**]
b. [**JB Industries**]
c. [**RectorSeal HVAC; a CSW Industrials Company**]
d. [**Refrigeration Sales, Inc.**]
e. <**Insert manufacturer's name**>

3. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant-charging ports from unauthorized refrigerant access and leakage.
4. Material: Brass, with protective shroud or sleeve.
5. Refrigerant Identification: [**Color-coded, refrigerant specific based on AHRI Guideline N**][**or**][**Universal**] design.
6. Special Tool: For installing and unlocking.

F. Solenoid Valves: Comply with **AHRI 760 I-P (AHRI 761 SI)** and UL 429; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body and Bonnet: Plated steel.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. End Connections: Threaded.
7. Electrical: Molded, watertight coil in ANSI/NEMA 250 enclosure of type required by location with **1/2-inch (16-mm)** conduit adapter, and [**24**][**115**][**208**] V ac coil.
8. Working Pressure Rating: [**400 psig (2760 kPa)**]<**Insert pressure**> .
9. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

G. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
4. Piston, Closing Spring, and Seat Insert: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. End Connections: Threaded.
7. Working Pressure Rating: [**400 psig (2760 kPa)**]<**Insert pressure**> .
8. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

H. Thermostatic Expansion Valves: Comply with **AHRI 750 I-P (AHRI 751 SI)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker Hannifin; Sporlan Division**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker Hannifin; Sporlan Division**]
    d. <**Insert manufacturer's name**>

3. Body, Bonnet, and Seal Cap: Forged brass or steel.
4. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
5. Packing and Gaskets: Non-asbestos.
6. Capillary and Bulb: Copper tubing filled with refrigerant charge.
7. Suction Temperature: [**40 deg F (4.4 deg C)**]<**Insert temperature**> .
8. Superheat: [**Adjustable**][**Nonadjustable**] .
9. Design: Reverse-flow option (for heat-pump applications).
10. End Connections: Socket, flare, or threaded union.
11. Working Pressure Rating: [**700 psig (4820 kPa)**][**450 psig (3100 kPa)**]<**Insert value**> .

I. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

3. Body, Bonnet, and Seal Cap: Ductile iron or steel.
4. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
5. Packing and Gaskets: Non-asbestos.
6. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
7. Seat: Polytetrafluoroethylene.
8. Equalizer: [**Internal**][**External**] .
9. Electrical: Molded, watertight coil in ANSI/NEMA 250 enclosure of type required by location with **1/2-inch (16-GRC)** conduit adapter and [**24**][**115**][**208**] V ac coil.
10. End Connections: Socket.
11. Set Pressure: <**Insert psig (kPa)**> .
12. Throttling Range: Maximum **5 psig (34 kPa)**.
13. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
14. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

J. Straight-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

3. Body: Welded steel with corrosion-resistant coating.
4. Screen: 100-mesh stainless steel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
7. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

K. Angle-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

3. Body: Forged brass or cast bronze.
4. Drain Plug: Brass hex plug.
5. Screen: 100-mesh monel.
6. End Connections: Socket or flare.
7. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
8. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

L. Moisture/Liquid Indicators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. [**RLS LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. [**RLS LLC**]
    e. <**Insert manufacturer's name**>

3. Body: Forged brass.
4. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
5. Indicator: Color-coded to show moisture content in parts per million (ppm).
6. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
7. End Connections: Socket or flare.
8. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
9. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

M. Replaceable-Core Filter Dryers: Comply with **AHRI 730 I-P (AHRI 731 SI)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

3. Body and Cover: Painted-steel shell with ductile-iron cover, stainless steel screws, and neoprene gaskets.
4. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
5. Desiccant Media: Activated [**alumina**][**charcoal**] .
6. Design: Reverse flow (for heat-pump applications).

7. End Connections: Socket.
8. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: [2 psig (14 kPa)]<**Insert value**> .
10. Rated Flow: <**Insert** tons (kW)> .
11. Working Pressure Rating: [500 psig (3450 kPa)]<**Insert pressure**> .
12. Maximum Operating Temperature: [240 deg F (116 deg C)]<**Insert temperature**> .

N. Permanent Filter Dryers: Comply with AHRI 730 I-P (AHRI 731 SI).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. [**RLS LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. [**RLS LLC**]
    e. <**Insert manufacturer's name**>

3. Body and Cover: Painted-steel shell.
4. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
5. Desiccant Media: Activated [**alumina**][**charcoal**] .
6. Design: Reverse flow (for heat-pump applications).
7. End Connections: Socket.
8. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: [2 psig (14 kPa)]<**Insert value**> .
10. Rated Flow: <**Insert** tons (kW)> .
11. Working Pressure Rating: [500 psig (3450 kPa)]<**Insert pressure**> .
12. Maximum Operating Temperature: [240 deg F (116 deg C)]<**Insert temperature**> .

O. Mufflers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Emerson Climate Technologies; Emerson Electric Co.**]
    c. [**Henry Technologies Inc.; The Henry Group**]
    d. [**Parker Hannifin; Sporlan Division**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Emerson Climate Technologies; Emerson Electric Co.**]
    c. [**Henry Technologies Inc.; The Henry Group**]
    d. [**Parker Hannifin; Sporlan Division**]
    e. <**Insert manufacturer's name**>

3. Body: Welded steel with corrosion-resistant coating.
4. End Connections: Socket or flare.
5. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
6. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

P. Receivers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Henry Technologies Inc.; The Henry Group**]
    b. [**Parker Hannifin; Sporlan Division**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Henry Technologies Inc.; The Henry Group**]
    b. [**Parker Hannifin; Sporlan Division**]
    c. <**Insert manufacturer's name**>

3. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
4. Comply with UL 207; listed and labeled by an NRTL.
5. Body: Welded steel with corrosion-resistant coating.
6. Tappings: Inlet, outlet, liquid-level indicator, and safety-relief valve.
7. End Connections: Socket or threaded.
8. Working Pressure Rating: [**450 psig (3100 kPa)**]<**Insert pressure**> .
9. Maximum Operating Temperature: [**250 deg F (121 deg C)**]<**Insert temperature**> .

Q. Liquid Accumulators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Emerson Climate Technologies; Emerson Electric Co.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Emerson Climate Technologies; Emerson Electric Co.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body: Welded steel with corrosion-resistant coating.
4. End Connections: Socket or threaded.
5. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
6. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

2.6 REFRIGERANTS

A. R-32, ASHRAE 34: Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Arkema Inc.**]
b. [**Honeywell International Inc.**]
c. [**Mexichem Fluor, Inc. (Koura)**]
d. [**The Chemours Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arkema Inc.**]
b. [**Honeywell International Inc.**]
c. [**Mexichem Fluor, Inc. (Koura)**]
d. [**The Chemours Company**]
e. <**Insert manufacturer's name**>

B. R-454B, ASHRAE 34: R-32 (68.9 percent by mass) and R-1234yf (31.1 percent by mass).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Arkema Inc.**]
b. [**Honeywell International Inc.**]
c. [**Mexichem Fluor, Inc. (Koura)**]
d. [**The Chemours Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arkema Inc.**]
b. [**Honeywell International Inc.**]
c. [**Mexichem Fluor, Inc. (Koura)**]
d. [**The Chemours Company**]
e. <**Insert manufacturer's name**>

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

A. Refrigerant: [**R-454B**][**R-32**]<**Insert refrigerant**> .

B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 (DN 40) and Smaller, Annealed-Temper: Copper, Type ACR, annealed-temper tubing and [**wrought-copper fittings with brazed joints**][**ACR copper fittings with pressure-seal joints**] .

C. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 4 (DN 100) and Smaller, Drawn-Temper: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with brazed joints.

D. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 2 to NPS 4 (DN 50 to DN 100), Drawn-Temper: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with brazed joints.

E. Safety-Relief-Valve Discharge Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, Copper: Type ACR, [**drawn-temper**][**or**][**annealed-temper**] tubing and wrought-copper fittings with brazed joints.

F. Safety-Relief-Valve Discharge Piping for Conventional Air-Conditioning (Cooling-Only) Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

G. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 1-1/2 (DN 40) and Smaller, Annealed-Temper: Copper, Type ACR, annealed-temper tubing and [**wrought-copper fittings with brazed joints**][**ACR copper fittings with pressure-seal joints**] .

H. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 4 (DN 100) and Smaller, Drawn-Temper: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

I. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 2 to NPS 4 (DN 50 to DN 100), Drawn-Temper: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

J. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type ACR, [**drawn-temper**][**or**][**annealed-temper**] tubing and wrought-copper fittings with brazed joints.

K. Safety-Relief-Valve Discharge Piping for Heat-Pump Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

L. Refrigerant Tubing for Variable Refrigerant Flow System Applications:

1. Copper Tube: ASTM B280, Type ACR.
2. Wrought-Copper Fittings, Brazed Joints: ASME B16.50.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

M. Safety-Relief-Valve Discharge Tubing for VRF Applications, Copper: Type ACR, [**drawn-temper**][**or**][**annealed-temper**] tubing and wrought-copper fittings with brazed joints.

N. Safety-Relief-Valve Discharge Piping for VRF Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

3.2 INSTALLATION OF VALVES AND SPECIALTIES

A. Install [**diaphragm packless**][**packed-angle**] valves in suction and discharge lines of compressor.

B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install [**diaphragm packless**][**packed-angle**] valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety-relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside in accordance with ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Strainers: Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve [**, and in the suction line at the compressor**] .

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

N. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.3 INSTALLATION OF REFRIGERANT PIPING, GENERAL

A. Requirements in this article apply to all piping materials, except where more specific requirements are specified in various pipe and fittings installation articles below.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

C. Install refrigerant piping in accordance with ASHRAE 15.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping adjacent to machines to allow service and maintenance.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. See Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

L. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

M. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

N. Install refrigerant piping in protective conduit where installed belowground.

O. Install refrigerant piping in rigid or flexible conduit in locations where exposed to potential mechanical injury.

P. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.4 INSTALLATION OF COPPER TUBE AND FITTINGS

A. When brazing copper tubing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

B. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
3. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."

    a. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
    b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

4. Copper-tube, Pressure-Seal-Joint Fittings: Construct joints in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF STEEL PIPE AND FITTINGS

A. Pre-Installation Cleaning: Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

B. Joint Construction:

1. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
4. Threaded Joints: Thread steel pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

5. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
6. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12.
7. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Piping Attachments: Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than **20 ft. (6 m)** long.
2. Roller hangers and spring hangers for individual horizontal runs **20 ft. (6 m)** or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft. (6 m)** or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper tube.

D. Install hangers for metal tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting.

F. Support vertical runs of metal tubing and piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System must maintain test pressure at the manifold gauge throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

4. Prepare test and inspection reports.

3.8 SYSTEM CHARGING

A. Procedures: Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to **500 micrometers (67 Pa)**. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to **2 psig (14 kPa)**.
4. Charge system with a new filter-dryer core in charging line.

3.9 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Adjustments: Perform the following adjustments before operating the refrigeration system, in accordance with manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves but not bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 22 11 16 00E

Task	Specification	Specification Description
22 11 16 00	07 63 00 00	Common Work Results for Fire Suppression
22 11 16 00	22 05 00 00	Common Work Results for Plumbing
22 11 16 00	22 13 16 00	Sanitary Waste And Vent Piping
22 11 16 00	22 14 13 00	Storm Drainage Piping
22 11 16 00	07 63 00 00a	Common Work Results for HVAC

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SECTION 22 11 19 00 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Automatic water shutoff valve systems.
5. Balancing valves.
6. Temperature-actuated, water mixing valves.
7. Strainers for domestic water piping.
8. Outlet boxes.
9. Hose stations.
10. Hose bibbs.
11. Wall hydrants.
12. Ground hydrants.
13. Post hydrants.
14. Roof hydrants.
15. Drain valves.
16. Water-hammer arresters.
17. Trap-seal primer device.
18. Trap-seal primer systems.
19. Flexible connectors.
20. Water meters.

B. Related Requirements:

1. Section 220500 "Common Work Results for Plumbing."
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Section 224300 "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
6. Section 224700 "Drinking Fountains and Water Coolers."
7. Section 230923.18 "Leak Detection Instruments" for leak detection devices related to HVAC applications.
8. Section 331415 "Site Water Distribution Piping" for fire water-service backflow prevention devices.

1.2 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: [**125 psig (860 kPa)**]<**Insert value**> unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cash Acme Plumbing Products; an RWC brand**]
c. [**FEBCO; A WATTS Brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]

f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. **[Apollo Valves; a part of Aalberts Integrated Piping Systems]**
b. **[Cash Acme Plumbing Products; an RWC brand]**
c. **[FEBCO; A WATTS Brand]**
d. **[WATTS; A Watts Water Technologies Company]**
e. **[Zurn Industries, LLC]**
f. **<Insert manufacturer's name>**

3. Standard: ASSE 1001.
4. Size: **NPS 1/4 to NPS 3 (DN 8 to DN 80)**, as required to match connected piping.
5. Body: Bronze.
6. Inlet and Outlet Connections: Threaded.
7. Finish: **[Rough bronze][Chrome plated]**.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. **[Apollo Valves; a part of Aalberts Integrated Piping Systems]**
b. **[Cash Acme Plumbing Products; an RWC brand]**
c. **[Champion-Arrowhead]**
d. **[Jay R. Smith Mfg Co; a division of Morris Group International]**
e. **[MIFAB, Inc]**
f. **[WATTS; A Watts Water Technologies Company]**
g. **[Woodford Manufacturing Company]**
h. **[Zurn Industries, LLC]**
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. **[Apollo Valves; a part of Aalberts Integrated Piping Systems]**
b. **[Cash Acme Plumbing Products; an RWC brand]**
c. **[Champion-Arrowhead]**
d. **[Jay R. Smith Mfg Co; a division of Morris Group International]**
e. **[MIFAB, Inc]**
f. **[WATTS; A Watts Water Technologies Company]**
g. **[Woodford Manufacturing Company]**
h. **[Zurn Industries, LLC]**
i. **<Insert manufacturer's name>**

3. Standard: ASSE 1011.
4. Body: Bronze, nonremovable, with manual drain.
5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
6. Finish: **[Chrome or nickel plated][Rough bronze]**.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**FEBCO; A WATTS Brand**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**FEBCO; A WATTS Brand**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

3. Standard: ASSE 1020.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: [**5 psig (35 kPa)**]<**Insert value**> maximum, through middle third of flow range.
6. Size: <**Insert NPS (DN)**>.
7. Design Flow Rate: <**Insert gpm (L/s)**>.
8. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
9. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**>.
10. Accessories:

    a. Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. [**Zurn Industries, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. [**Zurn Industries, LLC**]
    d. <**Insert manufacturer's name**>

3. Standard: ASSE 1035.
4. Size: **NPS 1/4 or NPS 3/8 (DN 8 or DN 10)** matching faucet size.

5. Body: Bronze.
6. End Connections: Threaded.
7. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

3. Standard: ASSE 1056.
4. Operation: Continuous-pressure applications.
5. Size: [**NPS 3/8 (DN 10)**][**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**].
6. Accessories:

   a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Caleffi North America**]
   c. [**Cash Acme Plumbing Products; an RWC brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Caleffi North America**]
   c. [**Cash Acme Plumbing Products; an RWC brand**]

d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Standard: ASSE 1012.
4. Operation: Continuous-pressure applications.
5. Size: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**].
6. Body: Bronze.
7. End Connections: [**Union, solder**][**Solder**] joint.
8. Finish: [**Rough bronze**]<**Insert finish**>.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Caleffi North America**]
d. [**FEBCO; A WATTS Brand**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Caleffi North America**]
d. [**FEBCO; A WATTS Brand**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Standard: ASSE 1013.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: [**12 psig (83 kPa)**]<**Insert value**> maximum, through middle third of flow range.
6. Size: <**Insert NPS (DN)**>.
7. Design Flow Rate: <**Insert gpm (L/s)**>.
8. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
9. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**> for sizes **NPS 2 (DN 50)** and smaller; <**Insert psig (kPa)**> for **NPS 2-1/2 (DN 65)** and larger.
10. Body: [**Bronze**][**cast silicon copper alloy**][**or**][**stainless steel**] for **NPS 2 (DN 50)** and smaller; [**ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved**][**or**][**stainless steel**] for **NPS 2-1/2 (DN 65)** and larger.
11. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.
12. Configuration: Designed for [**horizontal, straight-through**][**vertical-inlet, horizontal-center-section, and vertical-outlet**][**vertical**]<**Insert configuration**> flow.
13. Accessories:

a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**FEBCO; A WATTS Brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**FEBCO; A WATTS Brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Standard: ASSE 1015.
4. Operation: Continuous-pressure applications unless otherwise indicated.
5. Pressure Loss: [**5 psig (35 kPa)**]<**Insert value**> maximum, through middle third of flow range.
6. Size: <**Insert NPS (DN)**>.
7. Design Flow Rate: <**Insert gpm (L/s)**>.
8. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
9. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**> for sizes **NPS 2 (DN 50)** and smaller; <**Insert psig (kPa)**> for **NPS 2-1/2 (DN 65)** and larger.
10. Body: [**Bronze**][**cast silicon copper alloy**][**or**][**stainless steel**] for **NPS 2 (DN 50)** and smaller; [**ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved**][**or**][**stainless steel**] for **NPS 2-1/2 (DN 65)** and larger.
11. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.
12. Configuration: Designed for [**horizontal, straight-through**]<**Insert configuration**> flow.
13. Accessories:

a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Beverage-Dispensing-Equipment Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Standard: ASSE 1022.
4. Operation: Continuous-pressure applications.
5. Size: **NPS 1/4 or NPS 3/8 (DN 8 or DN 10)**.
6. Body: [**Stainless steel or non-metallic**]<**Insert material**>.
7. End Connections: Threaded or flare.

E. Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cash Acme Plumbing Products; an RWC brand**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cash Acme Plumbing Products; an RWC brand**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Standard: ASSE 1024.
4. Operation: Continuous-pressure applications.
5. Size: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**][**NPS 1-1/4 (DN 32)**].
6. Body: Bronze with union inlet.

F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**WATTS; A Watts Water Technologies Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**WATTS; A Watts Water Technologies Company**]
b. <**Insert manufacturer's name**>

3. Standard: ASSE 1032.
4. Operation: Continuous-pressure applications.
5. Size: **NPS 1/4 or NPS 3/8 (DN 8 or DN 10)**.
6. Body: Stainless steel.
7. End Connections: Threaded or flare.

G. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Woodford Manufacturing Company**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Woodford Manufacturing Company**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Standard: ASSE 1052.
4. Operation: Up to **10-ft. head of water (30-kPa)** back pressure.
5. Inlet Size: **NPS 3/4 (DN 20)**.
6. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
7. Capacity: At least **3-gpm (0.19-L/s)** flow.

H. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**FEBCO; A WATTS Brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**FEBCO; A WATTS Brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Factory calibrated, with gauges, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Caleffi North America**]
c. [**Cash Acme Plumbing Products; an RWC brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Caleffi North America**]
c. [**Cash Acme Plumbing Products; an RWC brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Standard: ASSE 1003.
4. Pressure Rating: Initial working pressure of **150 psig (1035 kPa)**.
5. Size: <**Insert NPS (DN)**>.
6. Design Flow Rate: <**Insert gpm (L/s)**>.
7. Design Inlet Pressure: <**Insert psig (kPa)**>.
8. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.

9. Body: Bronze[**with chrome-plated finish**] for **NPS 2 (DN 50)** and smaller; [**bronze**][**cast iron with interior lining that complies with AWWA C550 or that is FDA approved**] for **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**.
10. Valves for Booster Heater Water Supply: Include integral bypass.
11. End Connections: Threaded or solder for **NPS 2 (DN 50)** and smaller; flanged or solder for **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**.

B. Water-Control Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**CLA-VAL**]
    c. [**Flomatic Valves; Flomatic Corporation**]
    d. [**IMI Hydronic Engineering Inc**]
    e. [**OCV Control Valves**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Zurn Industries, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**CLA-VAL**]
    c. [**Flomatic Valves; Flomatic Corporation**]
    d. [**IMI Hydronic Engineering Inc**]
    e. [**OCV Control Valves**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Zurn Industries, LLC**]
    h. <**Insert manufacturer's name**>

3. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
4. Pressure Rating: Initial working pressure of **150 psig (1035 kPa)** minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
5. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless steel body.

    a. Size: <**Insert NPS (DN)**>.
    b. Pattern: [**Angle**][**Globe**]-valve design.
    c. Trim: Stainless steel.

6. Design Flow: <**Insert gpm (L/s)**>.
7. Design Inlet Pressure: <**Insert psig (kPa)**>.
8. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.
9. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.

2.6 AUTOMATIC WATER SHUTOFF VALVE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**FloLogic, Inc.**]
2. [**OnSite PRO Inc**]
3. [**QMI Manufacturing Inc.**]
4. [**RectorSeal Plumbing; A CSW Industrials Company**]
5. [**Reliance Detection Technologies**]
6. [**WaterCop**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**FloLogic, Inc.**]
2. [**OnSite PRO Inc**]
3. [**QMI Manufacturing Inc.**]
4. [**RectorSeal Plumbing; A CSW Industrials Company**]
5. [**Reliance Detection Technologies**]
6. [**WaterCop**]
7. <**Insert manufacturer's name**>

C. Shutoff Control Ball Valves and Actuators <**Insert drawing designation if any**>:

1. Size: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**][**NPS 1-1/4 (DN 32)**][**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**]<**Insert pipe size**>.
2. Design Flow Rate: <**Insert gpm (L/s)**>.
3. Design Inlet Pressure: <**Insert psig (kPa)**>.
4. Control Valve: Two-piece, full-port brass ball valve, MSS SP-110.
    a. End Connections: Threaded, female.
    b. Fittings: One **3/8-by-1/2-inch (9.5-by-12.7-mm)** male compression and one **3/8-by-1/2-inch (9.5-by-12.7-mm)** female compression.
    c. Seats: PTFE.
    d. O-Rings: FKM.
    e. Stem: Low-lead brass. Blowout proof.
    f. CWP Rating: [**600 psig (4140 kPa)**]<**Insert value**>.
5. Manual-override control turn-knob for emergency operation of valve.
6. Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, fails closed.
    a. Power Supply: [**Battery**][**120 V ac**][**120 V ac step-down transformer**][**with cord and plug**].
    b. Manual Intervention: Allowed.
    c. Position Indicator: Standard.
7. Actuator Enclosure: Suitable for ambient conditions encountered by application.
8. Wireless Leak Detection System:
    a. Sensor-Water Flow Type: Pipe-mounted to detect water flow.
    b. Sensor-Rope Type: Absorbent water sensing rope constructed from twisted metal

conductor wires insulated from one another and surrounded by polyethylene mesh braid jacket to detect water presence.

c. Wireless Signal Range: **100 ft. (30.5 m)** minimum between sensors and receiver.
d. Self-monitoring enabled system; faults for lost communication between receiver and sensor(s).
e. Onboard Battery Backup: 48 hours of protection.[**Valve to close prior to backup failure.**]
f. LED Indicators: Wireless signal strength, communication loss, water fault, low-temperature fault, and low battery.
g. FCC-Approved Wireless Communication System: Between sensors, repeaters, and receivers.
h. Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
i. Wireless Signal Repeater: Boosts signal performance between wireless sensors and receiver.

1) Push-button pairing and unpairing, into and out of the network.
2) Visual indication of wireless signal strength, low battery, and lost communication.
3) Standard wall outlet, 120 V ac, power.
4) Battery Backup: Two (2) AA batteries for battery backup to maintain system integrity during a power outage.

j. Wireless Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.
k. Hard-Wired Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.

9. Wired Leak Detection System:

a. Power Supply: Class II transformer with cord and plug, 120 V ac, UL listed.
b. Power Cord Length: [**12 ft. (3.66 m)**]<**Insert dimension**>.
c. Control Panel: LED power and LED valves indicator.
d. Alarms: Audible alarm[**, with external output**].
e. Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
f. Wired Sensors:

1) Quantity Per Receiver: [**One**][**Two**][**Three**][**Four**][**Five**][**Six**].

g. Cable Length: [**8 ft. (2.44 m)**][**25 ft. (7.62 m)**][**50 ft. (15.2 m)**][**100 ft. (30.5 m)**]<**Insert dimension**>.
h. Cable Adder: [**10 ft. (3 m)**][**25 ft. (7.62 m)**][**50 ft. (15.2 m)**][**100 ft. (30.5 m)**]<**Insert dimension**> in length.

D. Shutoff Control Butterfly Valve and Actuator <**Insert drawing designation if any**>:

1. Size: [**NPS 2-1/2 (DN 65)**][**NPS 3 (DN 80)**][**NPS 4 (DN 100)**]<**Insert pipe size**>.
2. Compliance: MSS SP-67.
3. Full-port, epoxy-coated, ductile-iron lug body.
4. Seat: EPDM, **minus 30 deg F to plus 250 deg F (minus 34 deg C to plus 121 deg C)**.
5. Face-to-Face Flange: ASME B16.5 flanges.
6. Disc Design: Floating stainless steel dual shaft.
7. Disc Material: Coated ductile iron.
8. Locating Pin: Carbon steel.
9. Bushings: PTFE.
10. O-Rings: EPDM.
11. Ten-position stop.

12. Manual-override control turn-knob for emergency operation of valve.
13. Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, fails closed.

    a. Power Supply: [**Battery**][**120 V ac**][**120 V ac step-down transformer**][**with cord and plug**].
    b. Manual Intervention: Allowed.
    c. Position Indicator: Standard.

14. Actuator Enclosure: Suitable for ambient conditions encountered by application.
15. Wireless Leak Detection System:

    a. Sensor-Water Flow Type: Pipe-mounted to detect water flow.
    b. Sensor-Rope Type: Absorbent water sensing rope constructed from twisted metal conductor wires insulated from one another and surrounded by polyethylene mesh braid jacket to detect water presence.
    c. Wireless Signal Range: **100 ft. (30.5 m)** minimum between sensors and receiver.
    d. Self-monitoring enabled system; faults for lost communication between receiver and sensor(s).
    e. Onboard Battery Backup: 48 hours of protection.[**Valve to close prior to backup failure.**]
    f. LED Indicators: Wireless signal strength, communication loss, water fault, low-temperature fault, and low battery.
    g. FCC-Approved Wireless Communication System: Between sensors, repeaters, and receivers.
    h. Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
    i. Wireless Signal Repeater: Boosts signal performance between wireless sensors and receiver.

        1) Push-button pairing and unpairing, into and out of the network.
        2) Visual indication of wireless signal strength, low battery, and lost communication.
        3) Standard wall outlet, 120 V ac, power.
        4) Battery Backup: Two (2) AA batteries for battery backup to maintain system integrity during a power outage.

    j. Wireless Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.
    k. Hard-Wired Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.

16. Wired Leak Detection System:

    a. Power Supply: Class II transformer with cord and plug, 120 V ac, UL listed.
    b. Power Cord Length: [**12 ft. (3.66 m)**]<**Insert dimension**>.
    c. Control Panel: LED power and LED valves indicator.
    d. Alarms: Audible alarm[**, with external output**].
    e. Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
    f. Wired Sensors:

        1) Quantity Per Receiver: [**One**][**Two**][**Three**][**Four**][**Five**][**Six**].

    g. Cable Length: [**8 ft. (2.44 m)**][**25 ft. (7.62 m)**][**50 ft. (15.2 m)**][**100 ft. (30.5 m)**]<**Insert dimension**>.
    h. Cable Adder: [**10 ft. (3 m)**][**25 ft. (7.62 m)**][**50 ft. (15.2 m)**][**100 ft. (30.5 m)**]<**Insert**

dimension> in length.

E. Clothes Washer Shutoff Control Valve and Actuator <**Insert drawing designation if any**>:

1. Brass or stainless steel ball valve.
2. End Connections: Male hose connections, **NPS 3/4 (DN 20)**.
3. Pressure Rating: **400 psi (2758 kPa)** at **32 to 150 deg F (0 to 65.6 deg C)**.
4. Valve Actuator:

    a. Enclosure: Suitable for ambient conditions encountered by application.
    b. Power Supply: [**Battery**][**120 V ac**][**120 V ac step-down transformer**][**with cord and plug**].
    c. Position Indicator: Standard.

5. Wired Leak Detection System:

    a. Water sensor with minimum **6-ft. (1.8-m)** length of wire.
    b. 120 V ac step-down transformer with cord and plug.
    c. LED operation and leak notification.
    d. Audible alarm.
    e. Power failure or manual disconnection of power causes valves to close.

F. Accessories:

1. Electrical Plug Interrupter: Plugs into standard 120 V ac wall outlet.
2. Gas Flow Interrupter: ECO connector with female spade connectors. Factory prewired, **8 ft. (2.44 m)**.
3. Gas Interface Cable: Interface cable with male and female connectors.
4. Step-Down Transformer: [**120**][**208**][**240**] V ac to 24 V ac with mounting plate, **12-ft. (3.66-m)** plenum wire to power, and **8-ft. (2.44-m)** plenum wire to sensor.
5. Liquid Level Sensors: Monitor fluid levels in addition to detecting plumbing leaks.
6. Auto Dialer: Send and receive automatic alerts when a fault condition occurs. Standard output contacts trigger up to nine predetermined telephone number calls.

    a. Prerecord message for future playback.
    b. 10-second recordable message.
    c. Built-in tamper switch.
    d. DC adaptor with battery backup.
    e. Programmable as a silent (dialer only) or audible (siren and dialer) alarm.
    f. Easy "Stop Call Sequence" - push "#" on phone to acknowledge the alarm and stop the dialing sequence.

7. Cellular Text Notification System:

    a. Event SMS text notification to up to three cell phones.
    b. Battery Backup: Four (4) AA batteries.
    c. **12-ft. (3.66-m)** interface cable to leak detection system.
    d. Customized messaging.
    e. <**Insert wireless network service provider**>.

2.7 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Bell & Gossett; a Xylem brand**]
b. [**IMI Hydronic Engineering Inc**]
c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
d. [**NIBCO INC.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bell & Gossett; a Xylem brand**]
b. [**IMI Hydronic Engineering Inc**]
c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
d. [**NIBCO INC.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. <**Insert manufacturer's name**>

3. Type: [**Ball**][**or**][**Y-pattern globe**] valve with two readout ports and memory-setting indicator.
4. Body: [**Brass**][**or**][**bronze**].
5. Size: Same as connected piping, but not larger than **NPS 2 (DN 50)**.
6. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Caleffi North America**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Caleffi North America**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]

g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

3. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
4. Pressure Rating: **400-psig (2760-kPa)** minimum CWP.
5. Size: **NPS 2 (DN 50)** or smaller.
6. Body: Copper alloy.
7. Port: Standard or full port.
8. Ball: Chrome-plated brass or stainless steel.
9. Seats and Seals: Replaceable.
10. End Connections: Solder joint or threaded.
11. Handle: Vinyl-covered steel with memory-setting device.

C. Automatic Flow Control Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Caleffi North America**]
c. [**IMI Hydronic Engineering Inc**]
d. [**ThermOmegaTech**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Caleffi North America**]
c. [**IMI Hydronic Engineering Inc**]
d. [**ThermOmegaTech**]
e. <**Insert manufacturer's name**>

3. Flow Regulation: Plus or minus 5 percent over 95 percent of the working range.
4. Pressure Rating: **200 psig (1380 kPa)**.
5. Size: **NPS 2 (DN 50)** or smaller.
6. Body: Stainless steel or brass.
7. Flow Cartridge: Stainless steel or antiscale polymer.
8. End Connections: Threaded or solder joint.

2.8 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Controls; a Division of Morris Group International**]

b. [**Acorn Engineering Company; a Division of Morris Group International**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Cash Acme Plumbing Products; an RWC brand**]
e. [**POWERS; A Watts Water Technologies Company**]
f. [**Symmons Industries, Inc**]
g. [**Taco Comfort Solutions**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Acorn Engineering Company; a Division of Morris Group International**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Cash Acme Plumbing Products; an RWC brand**]
e. [**POWERS; A Watts Water Technologies Company**]
f. [**Symmons Industries, Inc**]
g. [**Taco Comfort Solutions**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

3. Standard: ASSE 1070.
4. Pressure Rating: **125 psig (860 kPa)**.
5. Type: Thermostatically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded[**union**] inlets and outlet.
8. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Valve Finish: [**Chrome plated**][**Rough bronze**].

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Acorn Engineering Company; a Division of Morris Group International**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Caleffi North America**]
e. [**Cash Acme Plumbing Products; an RWC brand**]
f. [**Lawler Manufacturing Company, Inc**]
g. [**POWERS; A Watts Water Technologies Company**]
h. [**Symmons Industries, Inc**]
i. [**WATTS; A Watts Water Technologies Company**]
j. [**Zurn Industries, LLC**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Controls; a Division of Morris Group International**]
    b. [**Acorn Engineering Company; a Division of Morris Group International**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Caleffi North America**]
    e. [**Cash Acme Plumbing Products; an RWC brand**]
    f. [**Lawler Manufacturing Company, Inc**]
    g. [**POWERS; A Watts Water Technologies Company**]
    h. [**Symmons Industries, Inc**]
    i. [**WATTS; A Watts Water Technologies Company**]
    j. [**Zurn Industries, LLC**]
    k. <**Insert manufacturer's name**>

3. Standard: ASSE 1017.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Type: [**Exposed-mounted**][**Cabinet-type**], thermostatically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded[**union**] inlets and outlet.
8. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Selected Valve Flow Rate at 45-psig (310-kPa) Pressure Drop: <**Insert gpm (L/s)**>.
12. Pressure Drop at Design Flow Rate: <**Insert psig (kPa)**>.
13. Valve Finish: [**Chrome plated**][**Polished, chrome plated**][**Rough bronze**].
14. Piping Finish: [**Chrome plated**][**Copper**].
15. Cabinet: Factory fabricated, stainless steel, for [**recessed**][**surface**] mounting and with hinged, stainless steel door.

C. Primary, Electronic, Water Mixing Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Controls; a Division of Morris Group International**]
    b. [**Acorn Engineering Company; a Division of Morris Group International**]
    c. [**Caleffi North America**]
    d. [**Leonard Valve Company**]
    e. [**POWERS; A Watts Water Technologies Company**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Controls; a Division of Morris Group International**]
    b. [**Acorn Engineering Company; a Division of Morris Group International**]
    c. [**Caleffi North America**]
    d. [**Leonard Valve Company**]
    e. [**POWERS; A Watts Water Technologies Company**]
    f. <**Insert manufacturer's name**>

3. Standard: ASSE 1017.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Type: Exposed, electronically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded or solder joint inlets and outlet.
8. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Selected Valve Flow Rate at 45-psig (310-kPa) Pressure Drop: <**Insert gpm (L/s)**>.
12. Pressure Drop at Design Flow Rate: <**Insert psig (kPa)**>.
13. Valve Finish: Bronze.
14. Digital temperature control and monitoring module.

    a. Controls temperature within plus or minus **2 deg F (1 deg C)**.
    b. User programmable at module or through BAS.
    c. ASHRAE 188 compliance.
    d. Local and remote monitoring.
    e. [**BACNet**][**Modbus**][**Metasys**][**Ethernet**] protocol language(s).
    f. [**115**][**230**] V ac, 60 Hz.
    g. Battery backup.

D. Manifold, Thermostatic, Water Mixing Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**POWERS; A Watts Water Technologies Company**]
    c. [**Symmons Industries, Inc**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**POWERS; A Watts Water Technologies Company**]
    c. [**Symmons Industries, Inc**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, [**cabinet-type**][**exposed-mounted**], thermostatically controlled, water mixing valve assembly in [**two**][**three**]-valve parallel arrangement.
4. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gauges on inlet and outlet.
5. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gauges on inlet and outlet.
6. Small-Flow Parallel: Thermostatic, water mixing valve.
7. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
8. Water Regulator(s): Comply with ASSE 1003. Include pressure gauge on inlet and outlet.

9. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
10. Cabinet: Factory fabricated, stainless steel, for [**recessed**][**surface**] mounting and with hinged, stainless steel door.
11. Selected Large-Flow, Tempered-Water Valve Size: <**Insert size**>.
12. Tempered-Water Setting: <**Insert deg F (deg C)**>.
13. Unit Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
14. Unit Minimum Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
15. Selected Unit Flow Rate at **45-psig (310-kPa)** Pressure Drop: <**Insert gpm (L/s)**>.
16. Unit Pressure Drop at Design Flow Rate: <**Insert psig (kPa)**>.
17. Unit Tempered-Water Outlet Size: <**Insert NPS (DN)**> end connection.
18. Unit Hot- and Cold-Water Inlet Size: <**Insert NPS (DN)**> end connections.
19. Thermostatic Mixing Valve and Water Regulator Finish: [**Chrome plated**][**Polished, chrome plated**][**Rough bronze**].
20. Piping Finish: [**Chrome plated**][**Copper**].

E. Photographic-Process, Thermostatic, Water Mixing Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**POWERS; A Watts Water Technologies Company**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**POWERS; A Watts Water Technologies Company**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. <**Insert manufacturer's name**>

3. Standard: ASSE 1017, thermostatically controlled, water mixing valve made for precise, process-water temperature control.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, thermometer, shutoff valve, and adjustable, temperature-control handle.
8. Cabinet: Factory fabricated, stainless steel, for surface mounting; with controls and thermometer mounted on front.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Tempered-Water Outlet Size: <**Insert NPS (DN)**> end connection.
12. Hot- and Cold-Water Inlet Size: <**Insert NPS (DN)**> end connections.

F. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Controls; a Division of Morris Group International**]

b. [**Acorn Engineering Company; a Division of Morris Group International**]
c. [**Caleffi North America**]
d. [**Lawler Manufacturing Company, Inc**]
e. [**POWERS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Acorn Engineering Company; a Division of Morris Group International**]
c. [**Caleffi North America**]
d. [**Lawler Manufacturing Company, Inc**]
e. [**POWERS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Material: Bronze body with corrosion-resistant interior components.
6. Temperature Control: Adjustable.
7. Connections: Threaded inlets and outlet.
8. Finish: Chrome plated.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.

G. Primary Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Heat-Timer Corporation**]
c. [**Holby Valve Inc.**]
d. [**WATTS; A Watts Water Technologies Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Heat-Timer Corporation**]
c. [**Holby Valve Inc.**]
d. [**WATTS; A Watts Water Technologies Company**]
e. <**Insert manufacturer's name**>

3. Standard: ASSE 1017, thermostatically controlled, water tempering valve, listed as tempering valve.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Material: Bronze body.

6. Temperature Control: Manual.
7. Connections: Threaded inlets and outlet.
8. Selected Primary Water Tempering Valve Size: <**Insert size**>.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Pressure Drop at Design Flow Rate: <**Insert psig (kPa)**>.
12. Tempered-Water Outlet Size: <**Insert NPS (DN)**> end connection.
13. Cold-Water Inlet Size: <**Insert NPS (DN)**> end connection.
14. Hot-Water Inlet Size: <**Insert NPS (DN)**> end connection.
15. Valve Finish: [**Rough bronze**]<**Insert finish**>.

2.9 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Caleffi North America**]
    b. [**Keckley Company**]
    c. [**Titan Flow Control, Inc.**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Caleffi North America**]
    b. [**Keckley Company**]
    c. [**Titan Flow Control, Inc.**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

3. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
4. Body: Bronze for **NPS 2 (DN 50)** and smaller; cast iron[**with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and**] for **NPS 2-1/2 (DN 65)** and larger.
5. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; flanged for **NPS 2-1/2 (DN 65)** and larger.
6. Screen: Stainless steel with round perforations unless otherwise indicated.
7. Perforation Size:

    a. Strainers NPS 2 (DN 50) and Smaller: [**0.020 inch (0.51 mm)**][**0.033 inch (0.84 mm)**][**0.062 inch (1.57 mm)**]<**Insert dimension**>.
    b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**0.045 inch (1.14 mm)**][**0.062 inch (1.57 mm)**][**0.125 inch (3.18 mm)**]<**Insert dimension**>.
    c. Strainers NPS 5 (DN 125) and Larger: [**0.10 inch (2.54 mm)**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**]<**Insert dimension**>.

8. Drain: [**Pipe plug**][**Factory-installed, hose-end drain valve**].

2.10 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**Guy Gray, IPS Corporation**]
    c. [**LSP Products Group**]
    d. [**Oatey Co.**]
    e. [**Sioux Chief Manufacturing Company, Inc.**]
    f. [**Symmons Industries, Inc**]
    g. [**Water-Tite, IPS Corporation**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**Guy Gray, IPS Corporation**]
    c. [**LSP Products Group**]
    d. [**Oatey Co.**]
    e. [**Sioux Chief Manufacturing Company, Inc.**]
    f. [**Symmons Industries, Inc**]
    g. [**Water-Tite, IPS Corporation**]
    h. <**Insert manufacturer's name**>

3. Mounting: Recessed.[**Fire rated.**]
4. Material and Finish: [**Enameled-steel or epoxy-painted-steel**][**Enameled-steel, epoxy-painted-steel, or plastic**][**Plastic**][**Stainless steel**] box and faceplate.
5. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
6. Drain Outlet Connection: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**].
7. Accessory: Water hammer arresters.
8. Supply Shutoff Fittings: **NPS 1/2 (DN 15)** gate, globe, or ball valves and **NPS 1/2 (DN 15)** copper, water tubing.
9. Drain: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] standpipe and P-trap for direct waste connection to drainage piping.
10. Inlet Hoses: Two **60-inch- (1500-mm-)** long, rubber, household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
11. Drain Hose: One **48-inch- (1200-mm-)** long, rubber, household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Guy Gray, IPS Corporation**]

b. [**LSP Products Group**]
c. [**Oatey Co.**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Water-Tite, IPS Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Guy Gray, IPS Corporation**]
b. [**LSP Products Group**]
c. [**Oatey Co.**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Water-Tite, IPS Corporation**]
f. <**Insert manufacturer's name**>

3. Mounting: Recessed.[**Fire rated.**]
4. Material and Finish: [**Enameled-steel or epoxy-painted-steel**][**Enameled-steel, epoxy-painted-steel, or plastic**][**Plastic**][**Stainless steel**] box and faceplate.
5. Faucet: Valved fitting complying with ASME A112.18.1. Include **NPS 1/2 (DN 15)** or smaller copper tube outlet.
6. Accessory: Water hammer arrestor.
7. Supply Shutoff Fitting: **NPS 1/2 (DN 15)** gate, globe, or ball valve and **NPS 1/2 (DN 15)** copper, water tubing.

2.11 HOSE STATIONS

A. Single-Temperature-Water Hose Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARCHON Industries, Inc**]
b. [**Armstrong International, Inc**]
c. [**DynaFluid Ltd.**]
d. [**Strahman Valves, Inc**]
e. [**T&S Brass and Bronze Works, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARCHON Industries, Inc**]
b. [**Armstrong International, Inc**]
c. [**DynaFluid Ltd.**]
d. [**Strahman Valves, Inc**]
e. [**T&S Brass and Bronze Works, Inc.**]
f. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1.
4. Cabinet: Stainless steel enclosure with exposed valve handle, hose connection, and hose rack.

Include thermometer in front.

5. Hose-Rack Material: Stainless steel.
6. Body Material: Bronze[**with stainless steel wetted parts**].
7. Body Finish: Rough bronze[**, chrome plated**].
8. Mounting: [**Wall, with reinforcement**][**Floor, with stainless steel pedestal**].
9. Supply Fittings: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] gate, globe, or ball valve and check valve and [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper, water tubing. Omit check valve if check stop is included with fitting.
10. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [**25 ft. (7.6 m)**][**50 ft. (15 m)**]<**Insert dimension**> long.
11. Nozzle: With hand-squeeze, on-off control.
12. Vacuum Breaker:

    a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

B. Hot- and Cold-Water Hose Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARCHON Industries, Inc**]
    b. [**Armstrong International, Inc**]
    c. [**Cooney Brothers, Inc**]
    d. [**DynaFluid Ltd.**]
    e. [**Strahman Valves, Inc**]
    f. [**T&S Brass and Bronze Works, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ARCHON Industries, Inc**]
    b. [**Armstrong International, Inc**]
    c. [**Cooney Brothers, Inc**]
    d. [**DynaFluid Ltd.**]
    e. [**Strahman Valves, Inc**]
    f. [**T&S Brass and Bronze Works, Inc.**]
    g. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1.
4. Faucet Type: [**Blending**][**Thermostatic mixing**] valve.
5. Cabinet: Stainless steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
6. Hose-Rack Material: Stainless steel.
7. Body Material: Bronze[**with stainless steel wetted parts**].
8. Body Finish: Rough bronze[**or chrome plated**].
9. Mounting: [**Wall, with reinforcement**][**Floor, with stainless steel pedestal**].
10. Supply Fittings: Two [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] gate, globe, or ball valves and check valves and [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper, water tubing. Omit check valves if check stops are included with fitting.

11. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [**25 ft. (7.6 m)**][**50 ft. (15 m)**]<**Insert dimension**> long.
12. Nozzle: With hand-squeeze, on-off control.
13. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

C. Cold-Water and Steam Hose Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARCHON Industries, Inc**]
    b. [**Armstrong International, Inc**]
    c. [**DynaFluid Ltd.**]
    d. [**Strahman Valves, Inc**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ARCHON Industries, Inc**]
    b. [**Armstrong International, Inc**]
    c. [**DynaFluid Ltd.**]
    d. [**Strahman Valves, Inc**]
    e. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1.
4. Faucet Type: [**Blending**][**Thermostatic mixing**] valve.
5. Cabinet: Stainless steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
6. Hose-Rack Material: Stainless steel.
7. Body Material: Bronze[**with stainless steel wetted parts**].
8. Body Finish: Rough bronze[**or chrome plated**].
9. Mounting: [**Wall, with reinforcement**][**Floor, with stainless steel pedestal**].
10. Supply Fittings: Two [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] gate, globe, or ball valves and check valves and [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper, water tubing. Omit check valves if check stops are included with fitting.
11. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [**25 ft. (7.6 m)**][**50 ft. (15 m)**]<**Insert dimension**> long.
12. Nozzle: With hand-squeeze, on-off control.
13. Vacuum Breaker:

    a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.12 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Prier Products, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Prier Products, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1 for sediment faucets.
4. Body Material: Bronze.
5. Seat: Bronze, replaceable.
6. Supply Connections: **NPS 1/2 or NPS 3/4 (DN 15 or DN 20)** threaded or solder-joint inlet.
7. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
8. Pressure Rating: **125 psig (860 kPa)**.
9. Vacuum Breaker: Integral[**or field-installation,**] nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
10. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
11. Finish for Service Areas: [**Rough bronze**][**Chrome or nickel plated**].
12. Finish for Finished Rooms: Chrome or nickel plated.
13. Operation for Equipment Rooms: Wheel handle or operating key.
14. Operation for Service Areas: [**Wheel handle**][**Operating key**].
15. Operation for Finished Rooms: [**Wheel handle**][**Operating key**].
16. Include operating key with each operating-key hose bibb.
17. Include[**integral**] wall flange with each chrome- or nickel-plated hose bibb.

2.13 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]

c. [**MIFAB, Inc**]
d. [**Murdock Manufacturing; A Division of Morris Group International**]
e. [**Prier Products, Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Woodford Manufacturing Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Murdock Manufacturing; A Division of Morris Group International**]
e. [**Prier Products, Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Woodford Manufacturing Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M for [**concealed**][**exposed**]-outlet, self-draining wall hydrants.
4. Pressure Rating: **125 psig (860 kPa)**.
5. Operation: Loose key.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25)**.
8. Outlet, Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
9. Box: Deep, flush mounted with cover.
10. Box and Cover Finish: [**Polished nickel bronze**][**Rough bronze**]<**Insert finish**>.
11. Outlet, Exposed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
12. Nozzle and Wall-Plate Finish: [**Polished nickel bronze**][**Rough bronze**][**Chrome plated**]<**Insert finish**>.
13. Operating Keys(s): [**One**][**Two**] with each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Murdock Manufacturing; A Division of Morris Group International**]
e. [**Prier Products, Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Woodford Manufacturing Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Murdock Manufacturing; A Division of Morris Group International**]
e. [**Prier Products, Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Woodford Manufacturing Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M for [**concealed**][**exposed**]-outlet, self-draining wall hydrants.
4. Pressure Rating: **125 psig (860 kPa)**.
5. Operation: Loose key.
6. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
7. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25)**.
8. Outlet: Concealed.
9. Box: Deep, flush mounted with cover.
10. Box and Cover Finish: [**Polished nickel bronze**][**Chrome plated**]<**Insert finish**>.
11. Vacuum Breaker:

a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7 on outlet.

12. Operating Key(s): [**One**][**Two**] with each wall hydrant.

C. Moderate-Climate Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**MIFAB, Inc**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Prier Products, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**MIFAB, Inc**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Prier Products, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]

h. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M for [**concealed**][**exposed**]-outlet, self-draining wall hydrants.
4. Pressure Rating: **125 psig (860 kPa)**.
5. Operation: Loose key.
6. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25)**.
7. Outlet, Concealed:

   a. With integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
   b. Garden-hose thread complying with ASME B1.20.7.

8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: [**Polished nickel bronze**][**Chrome plated**]<**Insert finish**>.
10. Outlet, Exposed:

    a. With integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7.

11. Nozzle and Wall-Plate Finish: [**Polished nickel bronze**][**Rough bronze**]<**Insert finish**>.
12. Operating Key(s): [**One**][**Two**] with each wall hydrant.

D. Nonfreeze Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Champion-Arrowhead**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Prier Products, Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Woodford Manufacturing Company**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Champion-Arrowhead**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Prier Products, Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Woodford Manufacturing Company**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

3. Standard: ASSE 1019, Type A or Type B.
4. Type: Automatic draining with integral air-inlet valve.
5. Classification: [**Type A, for automatic draining with hose removed or**]Type B, for automatic draining with hose removed or with hose attached and nozzle closed.

6. Pressure Rating: **125 psig (860 kPa)**.
7. Operation: [**Loose key**][**or**][**wheel handle**].
8. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
9. Inlet: **NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**.
10. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.14 GROUND HYDRANTS

A. Nonfreeze Ground Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**Murdock Manufacturing; A Division of Morris Group International**]
    e. [**Prier Products, Inc.**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Woodford Manufacturing Company**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**Murdock Manufacturing; A Division of Morris Group International**]
    e. [**Prier Products, Inc.**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Woodford Manufacturing Company**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M.
4. Type: Nonfreeze, concealed-outlet ground hydrant with box.
5. Operation: Loose key.
6. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
7. Inlet: [**NPS 3/4 (DN 20)**]<**Insert pipe size**>.
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.
10. Box: [**Standard**][**Deep**] pattern with cover.
11. Box and Cover Finish: [**Rough**][**Polished nickel**]<**Insert finish**> bronze.
12. Operating Key(s): [**One**][**Two**] with each ground hydrant.
13. Vacuum Breaker: ASSE 1011.

2.15 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Murdock Manufacturing; A Division of Morris Group International**]
   e. [**Prier Products, Inc.**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Woodford Manufacturing Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Murdock Manufacturing; A Division of Morris Group International**]
   e. [**Prier Products, Inc.**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Woodford Manufacturing Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M.
4. Type: Nonfreeze, exposed-outlet post hydrant.
5. Operation: Loose key.
6. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
7. Casing: Bronze with casing guard.
8. Inlet: [**NPS 3/4 (DN 20)**]<**Insert pipe size**>.
9. Outlet: Garden-hose thread complying with ASME B1.20.7.
10. Drain: Designed with hole to drain into ground when shut off.
11. Vacuum Breaker:

    a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

12. Operating Key(s): [**One**][**Two**] with each loose-key-operation wall hydrant.

B. Nonfreeze Sanitary Yard Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hoeptner Products**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Woodford Manufacturing Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hoeptner Products**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Woodford Manufacturing Company**]
e. <**Insert manufacturer's name**>

3. Standard: ASSE 1057.
4. Operation: Wheel handle or lever.
5. Head: Cast iron or brass, with pail hook.
6. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25)** threaded.
7. Length: As required for burial of valve and canister below frost line.
8. Canister: [**Stainless steel**]<**Insert material**>.
9. Vacuum Breaker:

a. Removable hose-connection backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.16 ROOF HYDRANTS

A. Nonfreeze, Draining-Type Roof Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**MIFAB, Inc**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Prier Products, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**MIFAB, Inc**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Prier Products, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]

f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M.
4. Type: Nonfreeze, exposed-outlet roof hydrant with coated cast-iron head and lift handle with lock option. Provide with deck flange and under deck clamp.
5. Casing and Operating Rod: Bronze interior parts, galvanized-steel casing, and bronze valve housing designed with hole to drain.
6. Inlet: [**NPS 3/4 (DN 20)**]<**Insert pipe size**>.
7. Outlet: Garden-hose thread complying with ASME B1.20.7.
8. Vacuum Breaker:

a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.17 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: **400-psig (2760-kPa)** minimum CWP.
3. Size: **NPS 3/4 (DN 20)**.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: **NPS 3/4 (DN 20)**.
4. Body: ASTM B62 bronze.
5. Inlet: **NPS 3/4 (DN 20)** threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: **200-psig (1380-kPa)** minimum CWP or Class 125.
3. Size: **NPS 3/4 (DN 20)**.
4. Body: Copper alloy or ASTM B62 bronze.
5. Drain: **NPS 1/8 (DN 6)** side outlet with cap.

2.18 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMTROL, Inc.**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**Precision Plumbing Products**]
f. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMTROL, Inc.**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**Precision Plumbing Products**]
f. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

3. Standard: ASSE 1010 or PDI-WH 201.
4. Type: [**Metal bellows**][**Piston**][**Diaphragm**].
5. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.19 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Precision Plumbing Products**]
e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Precision Plumbing Products**]
e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Standard: ASSE 1018.
4. Pressure Rating: **125 psig (860 kPa)** minimum.
5. Body: Bronze.
6. Inlet and Outlet Connections: **NPS 1/2 (DN 15)** threaded, union, or solder joint.
7. Gravity Drain Outlet Connection: **NPS 1/2 (DN 15)** threaded or solder joint.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**MIFAB, Inc**]
c. [**Precision Plumbing Products**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**MIFAB, Inc**]
c. [**Precision Plumbing Products**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Standard: ASSE 1044, lavatory P-trap with **NPS 3/8 (DN 10)** minimum, trap makeup connection.
4. Size: **NPS 1-1/4 (DN 32)** minimum.
5. Material: Chrome-plated, cast brass.

2.20 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Precision Plumbing Products**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Precision Plumbing Products**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Standard: ASSE 1044.
4. Inlet Size: **NPS 3/4, ASTM B88, Type L (DN 20, ASTM B88M, Type B)**; copper, water tubing.
5. Cabinet: [**Recessed**][**Surface**]-mounted steel box with stainless steel cover.
6. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120 V ac power.

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

7. Vacuum Breaker: ASSE 1001.
8. Number Outlets: [**Four**][**Six**][**Eight**]<**Insert number**>.
9. Size Outlets: [**NPS 1/2 (DN 15)**][**NPS 5/8 (DN 18)**].

2.21 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Flex-Hose Co., Inc**]
2. [**Mason Industries, Inc.**]
3. [**Metraflex Company (The)**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Flex-Hose Co., Inc**]
2. [**Mason Industries, Inc.**]
3. [**Metraflex Company (The)**]
4. <**Insert manufacturer's name**>

C. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum [**200 psig (1380 kPa)**][**250 psig (1725 kPa)**].
2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

D. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum [**200 psig (1380 kPa)**][**250 psig (1725 kPa)**].
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.22 WATER METERS

A. Displacement-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Master Meter, Inc**]
d. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
e. [**Neptune Technology Group Inc.**]
f. [**Niagara Meters**]
g. [**Sensus; a Xylem brand**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Master Meter, Inc**]
d. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
e. [**Neptune Technology Group Inc.**]
f. [**Niagara Meters**]
g. [**Sensus; a Xylem brand**]
h. <**Insert manufacturer's name**>

3. Standard: AWWA C700.
4. Pressure Rating: **150-psig (1035-kPa)** working pressure.
5. Body Design: Nutating disc; totalization meter.
6. Registration: In **gallons (liters)** or **cubic feet (cubic meters)** as required by utility company.

a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

1) System to be capable of transmitting data using AMR/AMI technology.

7. Case: [**Bronze**][**Stainless steel**].
8. End Connections: Threaded or flanged.

B. Turbine-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
d. [**Neptune Technology Group Inc.**]
e. [**Niagara Meters**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
d. [**Neptune Technology Group Inc.**]
e. [**Niagara Meters**]
f. <**Insert manufacturer's name**>

3. Standard: AWWA C701.
4. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**> working pressure.
5. Body Design: Turbine; totalization meter.
6. Registration: In **gallons (liters)** or **cubic feet (cubic meters)** as required by utility company.

a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

1) System to be capable of transmitting data using AMR/AMI technology.

7. Case: [**Bronze**][**Epoxy-coated cast iron**].
8. End Connections: Threaded or flanged.

C. Compound-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
c. [**Neptune Technology Group Inc.**]
d. [**Sensus; a Xylem brand**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]

c. [**Neptune Technology Group Inc.**]
d. [**Sensus; a Xylem brand**]
e. <**Insert manufacturer's name**>

3. Standard: AWWA C702.
4. Pressure Rating: **150-psig (1035-kPa)** working pressure.
5. Body Design: With integral mainline and bypass meters; totalization meter.
6. Registration: In **gallons (liters)** or **cubic feet (cubic meters)** as required by utility company.

a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

1) System to be capable of transmitting data using AMR/AMI technology.

7. Case: [**Bronze**][**Coated ductile iron**].
8. End Connections: Flanged.

D. Ultrasonic-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Master Meter, Inc**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Master Meter, Inc**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

3. Standard: Applicable portions of AWWA C700.
4. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**> working pressure.
5. Body Design: Ultrasonic open flow tube; totalization meter.
6. Registration: In **gallons (liters)** or **cubic feet (cubic meters)** as required by utility company.

a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

1) System to be capable of transmitting data using AMR/AMI technology.

7. Case: [**Bronze**][**Stainless steel**][**Engineered polymer**][**Epoxy-coated ductile iron**].
8. End Connections: Threaded or flanged.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Water Regulators: Install with inlet and outlet shutoff valves[**and bypass with memory-stop balancing valve**]. Install pressure gauges on inlet and outlet.

C. Water Control Valves: Install with inlet and outlet shutoff valves[**and bypass with globe valve**]. Install pressure gauges on inlet and outlet.

D. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.

E. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

F. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Y-Pattern Strainers: For water, install on supply side of each [**control valve**][**water pressure-reducing valve**][**solenoid valve**][**and**][**pump**].

H. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install **1-1/2-by-3-1/2-inch (38-by-89-mm)** fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

I. Hose Stations: Install with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install **1-1/2-by-3-1/2-inch (38-by-89-mm)** fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

J. Ground Hydrants: Install with [**1 cu. yd. (0.75 cu. m)**]<**Insert dimension**> of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

K. Nonfreeze, Draining-Type Post Hydrants: Install with [**1 cu. yd. (0.75 cu. m)**]<**Insert dimension**> of crushed gravel around drain hole. Set post hydrants in concrete paving or in [**1 cu. ft. (0.03 cu. m)**]<**Insert dimension**> of concrete block at grade.

L. Nonfreeze, Nondraining-Type Post Hydrants: Set in concrete or pavement.

M. Nonfreeze, Sanitary Yard Hydrants: Set with riser pipe in concrete or pavement. Do not encase canister in concrete.

N. Nonfreeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.

O. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

P. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

Q. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

R. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Automatic water shutoff valve systems.
5. Balancing valves.
6. Temperature-actuated, water mixing valves.

7. Outlet boxes.
8. Hose stations.
9. Wall hydrants.
10. Ground hydrants.
11. Post hydrants.
12. Roof hydrants.
13. Trap-seal primer device.
14. Trap-seal primer systems.
15. Water meters.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each [**pressure vacuum breaker**][**reduced-pressure-principle backflow preventer**][**double-check, backflow-prevention assembly**][**and**][**double-check, detector-assembly backflow preventer**]<**Insert type**> in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Test each [**pressure vacuum breaker**][**reduced-pressure-principle backflow preventer**][**double-check, backflow-prevention assembly**][**and**][**double-check, detector-assembly backflow preventer**]<**Insert type**> according to authorities having jurisdiction and the device's reference standard.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 22 11 19 00

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SECTION 22 11 19 00A - ELECTRONIC AIR CLEANERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electronic air cleaners.
2. Fan section.
3. Cabinet.
4. Filter gauges.

B. Related Requirements:

1. Section 233119 "HVAC Casings" for customized housings used for particulate air filters.
2. Section 233416 "Centrifugal HVAC Fans" for customized fan and filter units.
3. Section 234133 "High-Efficiency Particulate Air Filtration" for high-efficiency particulate air filters used in combination with particulate air filters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For each electronic air cleaner.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Show filter assembly, dimensions, materials, and methods of assembly of components.
3. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
4. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for filters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each filter, for tests performed by [**manufacturer and witnessed by a**

qualified testing agency][**a qualified testing agency**].

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and housing to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide [**one**]<**Insert number**> complete set(s) of prefilters for each filter bank.
2. Provide detergent for [**one**][**two**]<**Insert number**> refill(s).
3. Provide [**one**]<**Insert number**> container(s) of red oil for inclined manometer filter gauge.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. Comply with AHRI 850.

D. Comply with [**NFPA 90A**][**NFPA 90B**].

E. Comply with UL 867.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a

qualified testing agency, and marked for intended location and application.

2.2 CAPACITIES AND CHARACTERISTICS

A. Drawing Tag. No.: <**Insert number**>.

B. Face Size: [**48 by 24 inches (1152 by 600 mm)**]<**Insert dimensions**> nominal.

C. Number of Cleaner Units: <**Insert number**>.

D. Unit Depth: <**Insert dimensions**> nominal.

E. Frame Access Location: [**Front**][**back**][**or**][**side**].

F. System Airflow: <**Insert number**> **cfm (L/s)**.

G. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert number**>.

H. Power Pack:

1. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: 60 Hz.
4. Full-Load Amperes: <**Insert number**> A.
5. Minimum Circuit Ampacity: <**Insert number**> A.

I. Maximum Overcurrent Protection Device: <**Insert number**> A.

J. Efficiency: <**Insert number**> percent on particles <**Insert number**> microns and larger at **500 fpm (2.5 m/s)**.

K. Initial Resistance: [**0.25-inch wg (63 Pa)**]<**Insert number**>.

L. Prefilter Type: Integral tracks to accommodate [**1-inch- (25-mm-)**][**2-inch- (50-mm-)**][**4-inch- (100-mm-)**] thick, disposable[**or washable**] filters.

1. Prefilter Face Size: <**Insert width by height**>.
2. Number of Prefilters, Wide by High: <**Insert number wide by number high**>.
3. Minimum Efficiency Reporting Value (MERV) and Average Arrestance: MERV [**4**]<**Insert number**>, with "Composite Average Particle Size Efficiency and Arrestance, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
4. Minimum Efficiency Reporting Value: MERV [**6**]<**Insert number**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

M. Final Filter Type: Integral tracks to accommodate [**12-inch (300-mm)**][**18-inch (450-mm)**][**24-inch (600-mm)**]<**Insert dimension**> disposable filters.

1. Final-Filter Face Size: <**Insert width by height**>.
2. Number of Final Filters, Wide by High: <**Insert number wide by number high**>.
3. Minimum Efficiency Reporting Value: MERV [**6**]<**Insert number**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

N. Fan Motor Electrical Characteristics:

1. Horsepower: <**Insert number**> hp.
2. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
3. Phase: [**Single**][**3**].
4. Hertz: 60 Hz.
5. Full-Load Amperes: <**Insert number**> A.
6. Minimum Circuit Ampacity: <**Insert number**> A.
7. Maximum Overcurrent Protection Device: <**Insert number**> A.

O. Cleaning System: [**Manual**][**or**][**automatic**].

P. Reservoir Tank: [**30 gal. (114 L)**][**50 gal. (190 L)**].

Q. Connections:

1. Water Supply: <**Insert number**> **NPS (DN)**.
2. Drain: <**Insert number**> **NPS (DN)**.

2.3 ELECTRONIC AIR CLEANERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air Quality Engineering, Inc.**]
2. [**CosaTron, a division of CRS Industries, Inc.**]
3. [**Trion, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air Quality Engineering, Inc.**]
2. [**CosaTron, a division of CRS Industries, Inc.**]
3. [**Trion, Inc.**]
4. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, electronic air cleaner operating by electrostatic precipitation principles.

D. Prefilter Media: [**Four**][**Six**] alternate layers of [**galvanized-steel**][**aluminum**][**stainless-steel**], flat and herringbone-crimp screen.

E. Prefilter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**flat**][**pleated**][**ring**] panel. Size and airflow capacity shall match those of electronic air cleaners.

1. Depth: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**]<**Insert dimension**>.
2. Comply with UL 900.

F. Final Filter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**supported bag**][**unsupported bag**][**rigid-cell box**][**V-bank cell**][**self-supported pocket**]. Size and airflow capacity shall match those of electronic air cleaners.

1. Depth: [**12 inches (300 mm)**][**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**>.
2. Comply with UL 900.

G. Collection Cells: Aluminum, independently supported and nested.

1. Ionizing Section: Alternately spaced grounded struts and charged ionizing wires.
2. Collecting Section: Alternately grounded and charged plates, with insulators located out of airstream.

H. Power Pack: Self-contained, prewired rectifying unit to convert power, as [**scheduled on Drawings**][**identified in "Capacities and Characteristics" Article**], to approximately 12,000 V dc for ionizer and 6000 V dc for collector; include overload protection, on-off switch, pilot light showing operating status, and access door interlock. Alternatively provide high-voltage and high-frequency-grid excitation technology power pack and system.

I. Safety Accessories: Manual-reset safety switches and warning lights for filter plenum access doors, signal lights and safety switching upstream and downstream from unit within duct, and enameled high-voltage warning signs.

J. Collection Section Cleaning System:

1. Detergent Reservoir Tank: [**30 gal. (110 L)**][**55 gal. (200 L)**]<**Insert capacity**> with pump, motor, solenoid valve, level sensor, backflow preventer, wye-strainer, and ball valve.
2. Detergent.
3. Dispensing System: Motor-driven oscillating copper manifolds with brass spray nozzles on each side of the collector.

K. Controls: Programmable logic controller in remotely mounted, NEMA 250, Type 12 enclosure; with integral time clock and manual override.

1. Contacts for enable-disable control by building automation system.

L. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with ASHRAE 62.1.

2.4 FAN SECTION

A. Fan: [**Forward curved, belt driven**]<**Insert fan and drive type**>.

B. Motor:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Type: [**Permanent-split capacitor with SCR for speed adjustment**][**Electronically commutated motor**]<**Insert type**>.
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: Totally enclosed, fan cooled, and [**explosion proof**][**dust-ignition proof**]<**Insert type**>.
5. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**]<**Insert type**>.
6. Motor Bearings: Sealed ball, <**Insert special requirements**>.
7. Unusual Service Conditions:

    a. Ambient Temperature: <**Insert number**> **deg F (deg C)**.
    b. Altitude: <**Insert number**> **feet (m)** above sea level.
    c. High humidity.
    d. <**Insert conditions**>.

8. Efficiency: Premium efficient.
9. NEMA Design: <**Insert designation**>.

10. Service Factor: <**Insert value**>.
11. Motor Speed: [**Single speed**][**Multispeed**][**Infinitely adjustable with electronic controls**].

2.5 CABINET

A. Description: Minimum <**Insert number**> **gauge (mm)** galvanized steel with <**Insert type**> finish for suspended, wall, frame, or duct mounting.

2.6 FILTER GAUGES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dwyer Instruments, Inc**]
2. [**Parker Hannifin Corporation; HVAC Filtration Division**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dwyer Instruments, Inc**]
2. [**Parker Hannifin Corporation; HVAC Filtration Division**]
3. <**Insert manufacturer's name**>

C. Description: Diaphragm type, with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Diameter: [**4-1/2 inches (115 mm)**][**2 inches (50 mm)**].
2. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: **0- to 0.5-inch wg (0 to 125 Pa)**.
3. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: **0- to 1.0-inch wg (0 to 250 Pa)**.
4. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: **0- to 2.0-inch wg (0 to 500 Pa)**.

D. Manometer-Type Filter Gauge: Molded plastic, with epoxy-coated aluminum scale, logarithmic-curve tube gauge, with integral leveling indicator, graduated to read from **0- to 3.0-inch wg (0 to 750 Pa)**, and accurate within 3 percent of full-scale range.

E. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine electronic air cleaners and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Position each electronic air cleaner unit with clearance for normal service and maintenance. Anchor electronic air cleaners to substrate.

B. Do not operate fan system until electronic air cleaners and associated prefilters and final filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

C. Operate electronic air cleaners for 24 hours as part of startup before units are put into operation.

D. Install filter-gauge, static-pressure taps upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

E. Install and connect water-supply and drainage piping.

F. Coordinate electronic air cleaner and associated prefilter and final filter installations with duct and air-handling-unit installations.

3.3 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between pressure sensors and [**DDC system**]<**Insert system description**>.

C. Connect control wiring between controlled devices.

D. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections: Test for leakage of unfiltered air while system is operating.

E. Electronic air cleaner and associated filters will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean electronic air filter housings and install new prefilter and final-filter media.

3.6 PROTECTION

A. Protect installed products and accessories from damage during construction.

END OF SECTION 22 11 19 00A

Task	Specification	Specification Description
22 11 19 00	07 63 00 00	Common Work Results for Fire Suppression
22 11 19 00	22 05 00 00	Common Work Results for Plumbing
22 11 19 00	07 63 00 00a	Common Work Results for HVAC
22 11 19 00	22 11 16 00d	Steam And Condensate Piping

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SECTION 22 11 23 13 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Constant-speed packaged booster pump, simplex.
2. Constant-speed packaged booster pump, multiplex.
3. Variable-speed packaged booster pump, simplex.
4. Variable-speed packaged booster pump, multiplex.

B. Related Requirements:

1. Section 221123.21 "Inline, Domestic-Water Pumps" for domestic-water circulation pumps.
2. Section 221223.11 "Facility Indoor Potable-Water Storage Tanks" for separate hydropneumatic domestic-water tanks for multiplex booster pumps.

1.2 DEFINITIONS

A. Domestic-water packaged booster pump assembly: Factory fabricated, assembled, and tested assembly of booster pumps, connecting piping, valves, controls, and electrical components mounted on a base.

B. PID: Proportional Integral Derivative.

C. VFC: Variable-frequency controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Construction details, material descriptions, and dimensions of individual components and profiles.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For packaged booster pumps.

1. Shop Drawing Scale: [**1/4 inch per foot (1:50)**].
2. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated Design Submittals: Comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Provide design calculations for selecting vibration isolators [**and seismic**

restraints] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which domestic-water packaged booster pump assembly is shown and coordinated with other installations, using input from installers of the items involved.

B. Seismic Qualification Certificates: For booster pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Limitation Reports: For factory testing of equipment.

D. Field Quality Control Reports: For specified tests and inspections.

E. Qualification Statements: For testing agency and factory-authorized service representative.

F. Delegated Design Engineer Qualifications: For domestic-water packaged booster pump assembly restraint and anchor design.

G. Sample Warranty: For specified special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged booster pumps.

1. Indicate the actual installed items by marking the submittals with an arrow or box.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [**, from the same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Authorized service representative who is trained and approved by manufacturer to perform [**manufacturer's field services**][**and**][**startup services**][**and**][**demonstration services**] .

B. Testing Agency Qualifications: An independent agency qualified to perform specified field tests.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type

indicated.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage and handling.

1.10 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace packaged booster pump components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**One**] year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic-water packaged booster pumps intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF/ANSI 61 and NSF/ANSI/CAN 372, or be certified in compliance with NSF/ANSI 61 and NSF/ANSI/CAN 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Seismic Performance: Domestic-water packaged booster pumps are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means that "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."

2. Component Importance Factor: [**1.5**][**1.0**] .

C. Delegated Design: Design restraints and anchors for domestic-water packaged booster pump assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2.2 CONSTANT-SPEED PACKAGED BOOSTER PUMP

A. Constant-Speed Packaged Booster Pump, Simplex:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Advanced Mechanical Technologies**]
   b. [**Canariis Corporation**]
   c. [**Delta P Carver**]
   d. [**Metropolitan Industries, Inc**]
   e. [**Thrush Co. Inc.**]
   f. [**TIGERFLOW Systems, Inc.**]

2. Source Limitations: Obtain constant-speed packaged booster pumps from single manufacturer.
3. Description: Simplex, constant-speed factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.

   a. Booster pump to be listed and labeled as a packaged pumping system by a testing agency acceptable to authorities having jurisdiction.

4. Standards:

   a. ASME Compliance: Comply with ASME B31.9 for piping.
   b. UL 508, "Industrial Control Equipment."
   c. UL 508A, "Industrial Control Panels."
   d. UL 778, "Motor-Operated Water Pumps."
   e. UL 1995, "Heating and Cooling Equipment."

5. Pump:

   a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
   b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
   c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
   e. Seal: Mechanical.
   f. Orientation: Mounted [**horizontally**][**vertically**] .

6. Motor: Single speed, with [**grease-lubricated**][**pre-greased, permanently shielded**] , ball-bearings, and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve.
7. Piping: [**Copper tube and copper fittings**][**Stainless steel pipe and fittings**][**Stainless steel pipe and fitting headers and copper tube and copper fittings between headers and pump**][**Galvanized-steel pipe and cast-iron fittings**] .
8. Valves:

   a. Shutoff Valves NPS 2 (DN 50) and Smaller: [**Gate valve**][**two-piece, full-port ball valve**] , in pump suction and discharge piping.
   b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: [**Gate valve**][**lug-type butterfly valve**] , in pump suction and discharge piping.

c. Check Valve NPS 2 (DN 50) and Smaller: [**Silent**][**swing**] type in pump discharge piping.
d. Check Valve NPS 2-1/2 (DN 65) and Larger: Silent type in pump discharge piping.
e. Control Valve with Separate Check Valve: Adjustable, automatic, [**pilot-operated**][**direct-acting**] , pressure-reducing type in pump discharge piping.

f. Control Valve: Combination adjustable, automatic, [**pilot-operated**][**direct-acting**] pressure-reducing-and-check type in pump discharge piping.
g. Thermal-Relief Valve: Temperature-and-pressure relief type in pump discharge piping.

9. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.
10. Hydropneumatic Tank: Precharged [**, ASME-construction,**] diaphragm or bladder tank made of materials complying with NSF/ANSI 61 and NSF/ANSI/CAN 372.
11. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for single-pump, constant-speed operation, with load control and protection functions.

a. Control Logic: [**Electromechanical system with switches, relays**][**Solid-state system with transducers, programmable microprocessor**] , and other devices in the controller.

b. Motor Controller, General Purpose: NEMA ICS 2, general-purpose, Class A, full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.

1) Control Voltage: [**24**][**120**] V ac, with integral control-power transformer.

c. Motor Controller, Solid State: NEMA ICS 2, solid-state, reduced-voltage type.

1) Control Voltage: [**24**][**120**] V ac, with integral control-power transformer.

d. Enclosure: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Type 12**].
e. Motor Overload Protection: Overload relay in each phase.
f. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.

g. Pump Operation: [**Current-**][**pressure-**] sensing method.

1) Time Delay: Controls pump on-off operation; adjustable from [**1 to 300**] seconds.

h. Instrumentation: Suction and discharge pressure gauges.
i. Light: Running light for pump.
j. Thermal-bleed cutoff.
k. [**Low-suction-pressure**][**Water-storage-tank, low-level**] cutout.

l. High-suction-pressure cutout.
m. Low-discharge-pressure cutout.
n. High-discharge-pressure cutout.
o. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to [**BACnet**][**LonWorks**] DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of pump.
2) Alarm status.

12. Base: Structural steel.

13. Capacities and Characteristics:

a. Minimum Pressure Rating: [125 psig (860 kPa)][150 psig (1035 kPa)].
b. Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**] V.
2) Phases: [**Single**][**Three**] .
3) Hertz: [**60**] Hz.

c. Hydropneumatic Tank:

1) Pressure Rating: [125 psig (860 kPa)][150 psig (1035 kPa)][250 psig (1725 kPa)].

B. Constant-Speed Packaged Booster Pump, Multiplex:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advanced Mechanical Technologies**]
b. [**Canariis Corporation**]
c. [**Metropolitan Industries, Inc**]
d. [**SyncroFlo, Inc.**]
e. [**Thrush Co. Inc.**]
f. [**TIGERFLOW Systems, Inc.**]

2. Source Limitations: Obtain constant-speed packaged booster pumps from single manufacturer.
3. Description: Multiplex, constant-speed factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

a. Booster pump to be listed and labeled as a packaged pumping system by a testing agency acceptable to authorities having jurisdiction.

4. Standards:

a. ASME Compliance: Comply with ASME B31.9 for piping.
b. UL 508, "Industrial Control Equipment."
c. UL 508A, "Industrial Control Panels."
d. UL 778, "Motor-Operated Water Pumps."
e. UL 1995, "Heating and Cooling Equipment."

5. Pumps, End Suction, Close Coupled:

a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Orientation: Mounted [**horizontally**][**vertically**] .

6. Pumps, End Suction, Frame Mounted, Separately Coupled:

a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction,

frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. [**Include back-pullout design.**]
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless steel [**or steel**] shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Bearing: [**Grease-lubricated**][**pre-greased, permanently shielded**] ball type.
g. Coupling: Flexible, with metal guard.

7. Pumps, In Line, Single Stage:

a. Type: In line, single stage as defined in ANSI/HI 14.1-14.2 and HI 14.3 for in-line, close-coupled, single-stage, overhung-impeller, centrifugal pump.
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless steel [**or steel**] shaft, with copper-alloy shaft sleeve.
e. Seal: Mechanical.
f. Bearing: [**Grease-lubricated**][**pre-greased, permanently shielded**] ball type.

8. Pumps, Vertical, Multistage:

a. Type: Vertical, multistage as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for in-line, separately coupled, multistage, overhung-impeller, centrifugal pump.
b. Casing: Cast-iron or steel base and stainless steel chamber.
c. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
d. Shaft: Stainless steel.
e. Seal: Mechanical.
f. Bearing: Water-lubricated sleeve type.

9. Pumps, Vertical, Turbine, Can:

a. Type: Vertical turbine, can, as defined in ANSI/HI 14.1-14.2 for in-line, barrel or can, lineshaft, vertical turbine pump.
b. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
c. Bowls: [**Epoxy-coated cast iron**][**Cast iron**].
d. Shaft: Stainless steel.
e. Seals: Mechanical and stuffing-box types.
f. Bearings: Water-lubricated bushing type.

10. Motors: Single speed, with [**grease-lubricated**][**pre-greased, permanently shielded**] , ball-bearings. Select motors that will not overload through full range of pump performance curve.
11. Piping: [**Copper tube and copper fittings**][**Stainless steel pipe and fittings**][**Stainless steel pipe and fitting headers and copper tube and copper fittings between headers and pump**][**Galvanized-steel pipe and cast-iron fittings**] .
12. Valves:

a. Shutoff Valves NPS 2 (DN 50) and Smaller: [**Gate valve**][**two-piece, full-port ball valve**] , in each pump's suction and discharge piping.
b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: [**Gate valve**][**lug-type butterfly valve**] , in each pump's suction and discharge piping [**and in inlet and outlet headers**] .
c. Check Valves NPS 2 (DN 50) and Smaller: [**Silent**][**swing**] type in each pump's discharge piping.
d. Check Valves NPS 2-1/2 (DN 65) and Larger: Silent type in each pump's discharge piping.

e. Control Valves with Separate Check Valve: Adjustable, automatic, [**pilot-operated**][**direct-acting**] , pressure-reducing type in each pump's discharge piping.

f. Control Valves: Combination adjustable, automatic, [**pilot-operated**][**direct-acting**] pressure-reducing-and-check type in each pump's discharge piping.

g. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

13. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.

14. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, constant-speed operation, with load control and protection functions.

a. Control Logic: [**Electromechanical system with switches, relays**][**Solid-state system with transducers, programmable microprocessor**] , and other devices in the controller.

b. Motor Controller, General Purpose: NEMA ICS 2, general-purpose, Class A, full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.

1) Control Voltage: [**24**][**120**] V ac, with integral control-power transformer.

c. Motor Controller, Solid State: NEMA ICS 2, solid-state, reduced-voltage type.

1) Control Voltage: [**24**][**120**] V ac, with integral control-power transformer.

d. Enclosure: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Type 12**].

e. Motor Overload Protection: Overload relay in each phase.

f. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

1) Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.
2) Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.

g. Pump Operation and Sequencing: [**Current-**][**pressure-**] sensing method.

1) Time Delay: Controls pump on-off operation; adjustable from [**1 to 300**] seconds.

h. Instrumentation: Suction and discharge pressure gauges.

i. Lights: Running light for each pump.

j. Alarm Signal Device: Sounds alarm when backup pumps are operating.

1) Time Delay: Controls alarm operation; adjustable from [**1 to 300**] seconds, with [**automatic**][**manual**] reset.

k. Thermal-bleed cutoff.

l. [**Low-suction-pressure**][**Water-storage-tank, low-level**] cutout.

m. High-suction-pressure cutout.

n. Low-discharge-pressure cutout.

o. High-discharge-pressure cutout.

p. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to [**BACnet**][**LonWorks**] DDC system. DDC systems are specified in Section 230923 "Direct-Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of each pump.
2) Alarm status.

15. Base: Structural steel.

16. Capacities and Characteristics:

a. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].

1) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**] V.
b) Phases: [**Single**][**Three**] .
c) Hertz: [**60**] Hz.

b. Lag Pumps: Each of [**two**].

1) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**] V.
b) Phases: [**Single**][**Three**] .
c) Hertz: [**60**] Hz.

2.3 VARIABLE-SPEED PACKAGED BOOSTER PUMP

A. Variable-Speed Packaged Booster Pump, Simplex:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advanced Mechanical Technologies**]
b. [**Canariis Corporation**]
c. [**Delta P Carver**]
d. [**QuantumFlo, Inc.**]
e. [**Taco Comfort Solutions**]
f. [**TIGERFLOW Systems, Inc.**]
g. [**Xylem**]

2. Source Limitations: Obtain variable-speed packaged booster pumps from single manufacturer.
3. Description: Simplex, variable-speed factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.

a. Booster pump to be listed and labeled as a packaged pumping system by a testing agency acceptable to authorities having jurisdiction.

4. Standards:

a. ASME Compliance: Comply with ASME B31.9 for piping.
b. UL 508, "Industrial Control Equipment."
c. UL 508A, "Industrial Control Panels."
d. UL 778, "Motor-Operated Water Pumps."

e. UL 1995, "Heating and Cooling Equipment."

5. Pump:

   a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
   b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
   c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
   e. Seal: Mechanical.
   f. Orientation: Mounted [**horizontally**][**vertically**] .

6. Motor: Single speed, with [**grease-lubricated**][**pre-greased, permanently shielded**] , ball-bearings, and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve.
7. Piping: [**Copper tube and copper fittings**][**Stainless steel pipe and fittings**][**Stainless steel pipe and fitting headers and copper tube and copper fittings between headers and pump**][**Galvanized-steel pipe and cast-iron fittings**] .
8. Valves:

   a. Shutoff Valves NPS 2 (DN 50) and Smaller: [**Gate valve**][**two-piece, full-port ball valve**] , in pump suction and discharge piping.
   b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: [**Gate valve**][**lug-type butterfly valve**] , in pump suction and discharge piping.
   c. Check Valve NPS 2 (DN 50) and Smaller: [**Silent**][**swing**] type in pump discharge piping.
   d. Check Valve NPS 2-1/2 (DN 65) and Larger: Silent type in pump discharge piping.
   e. Thermal-Relief Valve: Temperature-and-pressure relief type in pump discharge piping.

9. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.
10. Hydropneumatic Tank: Precharged [**, ASME-construction,**] diaphragm or bladder tank made of materials complying with NSF/ANSI 61 and NSF/ANSI/CAN 372.

11. VFC Specified in Other Section: Comply with Section 262923 "Variable-Frequency Motor Controllers."
12. VFC: Serving each pump in pump array.

    a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**] for [**Design A and Design B**][**inverter-duty**] motors.
    b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**] ; maximum voltage equals input voltage.
    c. Unit Operating Requirements:

       1) Internal Adjustability:

          a) Minimum Speed: 5 to 25 percent of maximum rpm.
          b) Maximum Speed: 80 to 100 percent of maximum rpm.
          c) Acceleration: [**0.1 to 999.9**] seconds.
          d) Deceleration: [**0.1 to 999.9**] seconds.
          e) Current Limit: 30 to minimum of 150 percent of maximum rating.

       2) Self-Protection and Reliability Features:

          a) Surge suppression.

b) Loss of input signal protection.
c) Under- and overvoltage trips.
d) VFC and motor overload/overtemperature protection.
e) Critical frequency rejection.
f) Loss-of-phase protection.
g) Reverse-phase protection.
h) Motor-overtemperature fault.

3) Bidirectional autospeed search.
4) Torque boost.
5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.
b) Historical logging information and displays.
c) Digital indicating devices.

6) Control Signal Interface: Electric.
7) PID control interface.
8) DDC System for HVAC Protocols for Network Communications: [**ASHRAE 135**].

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

e. Bypass Systems:

1) Bypass Mode: [**Manual operation only**][**Field-selectable automatic or manual**] .
2) Bypass Controller:

a) Two-contactor style, with bypass and output isolating contactors [**and isolating switch**] .
b) Three-contactor style, with bypass and input and output isolating contactors [**and isolating switch**] .

3) Bypass Contactor Configuration: [**Full-voltage (across the line)**][**Reduced-voltage (autotransformer)**] type.

f. Instrumentation: Suction and discharge pressure gauges.
g. Light: Running light for pump.
h. Thermal-bleed cutoff.
i. [**Low-suction-pressure**][**Water-storage-tank, low-level**] cutout.

j. High-suction-pressure cutout.
k. Low-discharge-pressure cutout.
l. High-discharge-pressure cutout.
m. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to [**BACnet**][**LonWorks**] DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of each pump.
2) Alarm status.

13. Base: Structural steel.

14. Capacities and Characteristics:

    a. Minimum Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**].
    b. Electrical Characteristics:

        1) Volts: [**120**][**240**][**277**][**480**] V.
        2) Phases: [**Single**][**Three**] .
        3) Hertz: [**60**] Hz.

    c. Hydropneumatic Tank:

        1) Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].

B. Variable-Speed Packaged Booster Pump, Multiplex:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Advanced Mechanical Technologies**]
    b. [**Armstrong Fluid Technology**]
    c. [**Canariis Corporation**]
    d. [**Delta P Carver**]
    e. [**Flo Fab Inc**]
    f. [**GRUNDFOS CBS Inc.**]
    g. [**Patterson Pump Company; a Gorman-Rupp company**]
    h. [**QuantumFlo, Inc.**]
    i. [**SyncroFlo, Inc.**]
    j. [**Taco Comfort Solutions**]
    k. [**Thrush Co. Inc.**]
    l. [**TIGERFLOW Systems, Inc.**]
    m. [**Xylem**]

2. Source Limitations: Obtain variable-speed packaged booster pumps from single manufacturer.
3. Description: Multiplex, variable-speed factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.

    a. Booster pump to be listed and labeled as a packaged pumping system by a testing agency acceptable to authorities having jurisdiction.

4. Standards:

    a. ASME Compliance: Comply with ASME B31.9 for piping.
    b. UL 508, "Industrial Control Equipment."
    c. UL 508A, "Industrial Control Panels."
    d. UL 778, "Motor-Operated Water Pumps."
    e. UL 1995, "Heating and Cooling Equipment."

5. Pumps, End Suction, Close Coupled:

    a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.

b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Orientation: Mounted [**horizontally**][**vertically**] .

6. Pumps, End Suction, Frame Mounted, Separately Coupled:

a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. [**Include back-pullout design.**]
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless steel [**or steel**] shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Bearing: [**Grease-lubricated**][**pre-greased, permanently shielded**] ball type.
g. Coupling: Flexible, with metal guard.

7. Pumps, In Line, Single Stage:

a. Type: In line, single stage as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for in-line, close-coupled, single stage overhung-impeller, centrifugal pump.
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless steel [**or steel**] shaft, with copper-alloy shaft sleeve.
e. Seal: Mechanical.
f. Bearing: [**Grease-lubricated**][**pre-greased, permanently shielded**] ball type.

8. Pumps, Vertical, Multistage:

a. Type: Vertical, multistage as defined in ANSI/HI 14.1-14.2 and ANSIHI 14.3 for in-line, multistage, separately coupled, overhung-impeller, centrifugal pump.
b. Casing: Cast-iron or steel base and stainless steel chamber.
c. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
d. Shaft: Stainless steel.
e. Seal: Mechanical.
f. Bearing: Water-lubricated sleeve type.

9. Pumps, Vertical, Turbine, Can:

a. Type: Vertical turbine, can, as defined in ANSI/HI 14.1-14.2 for in-line, barrel or can, lineshaft, vertical pump.
b. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
c. Bowls: [**Epoxy-coated cast iron**][**Cast iron**].
d. Shaft: Stainless steel.
e. Seals: Mechanical and stuffing-box types.
f. Bearings: Water-lubricated bushing type.

10. Motors: Single speed, with [**grease-lubricated**][**pre-greased, permanently shielded**] , ball-bearings. Select motors that will not overload through full range of pump performance curve.
11. Piping: [**Copper tube and copper fittings**][**Stainless steel pipe and fittings**][**Stainless steel pipe and fitting headers and copper tube and copper fittings between headers and**

pump][**Galvanized-steel pipe and cast-iron fittings**] .

12. Valves:

    a. Shutoff Valves NPS 2 (DN 50) and Smaller: [**Gate valve**][**two-piece, full-port ball valve**] , in each pump's suction and discharge piping.
    b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: [**Gate valve**][**lug-type butterfly valve**] , in each pump's suction and discharge piping [**and in inlet and outlet headers**] .
    c. Check Valves NPS 2 (DN 50) and Smaller: [**Silent**][**swing**] type in each pump's discharge piping.
    d. Check Valves NPS 2-1/2 (DN 65) and Larger: Silent type in each pump's discharge piping.
    e. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

13. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.

14. VFC Specified in Other Section: Comply with Section 262923 "Variable-Frequency Motor Controllers."
15. VFC: Serving each pump in pump array.

    a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**] for [**Design A and Design B**][**inverter-duty**] motors.
    b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**] ; maximum voltage equals input voltage.
    c. Unit Operating Requirements:

        1) Internal Adjustability:

            a) Minimum Speed: 5 to 25 percent of maximum rpm.
            b) Maximum Speed: 80 to 100 percent of maximum rpm.
            c) Acceleration: [**0.1 to 999.9**] seconds.
            d) Deceleration: [**0.1 to 999.9**] seconds.
            e) Current Limit: 30 to minimum of 150 percent of maximum rating.

        2) Self-Protection and Reliability Features:

            a) Surge suppression.
            b) Loss of input signal protection.
            c) Under- and overvoltage trips.
            d) VFC and motor overload/overtemperature protection.
            e) Critical frequency rejection.
            f) Loss-of-phase protection.
            g) Reverse-phase protection.
            h) Motor-overtemperature fault.

        3) Bidirectional autospeed search.
        4) Torque boost.
        5) Motor temperature compensation at slow speeds.

            a) Panel-mounted operator station.
            b) Historical logging information and displays.
            c) Digital indicating devices.

        6) Control Signal Interface: Electric.
        7) PID control interface.

8) DDC System for HVAC Protocols for Network Communications: [**ASHRAE 135**].

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

e. Bypass Systems:

1) Bypass Mode: [**Manual operation only**][**Field-selectable automatic or manual**] .
2) Bypass Controller:

a) Two-contactor style, with bypass and output isolating contactors [**and isolating switch**] .
b) Three-contactor style, with bypass and input and output isolating contactors [**and isolating switch**] .

3) Bypass Contactor Configuration: [**Full-voltage (across the line)**][**Reduced-voltage (autotransformer)**] type.

f. Instrumentation: Suction and discharge pressure gauges.
g. Lights: Running light for each pump.
h. Alarm Signal Device: Sounds alarm when backup pumps are operating.

1) Time Delay: Controls alarm operation; adjustable from [**1 to 300**] seconds, with [**automatic**][**manual**] reset.

i. Thermal-bleed cutoff.
j. [**Low-suction-pressure**][**Water-storage-tank, low-level**] cutout.

k. High-suction-pressure cutout.
l. Low-discharge-pressure cutout.
m. High-discharge-pressure cutout.
n. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to [**BACnet**][**LonWorks**] DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of each pump.
2) Alarm status.

16. Base: Structural steel.

17. Capacities and Characteristics:

a. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].
b. Lead Pump:

1) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**] V.
b) Phases: [**Single**][**Three**] .
c) Hertz: [**60**] Hz.

c. Lag Pumps: Each of [**two**].

1) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**] V.
b) Phases: [**Single**][**Three**] .
c) Hertz: [**60**] Hz.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of packaged booster pumps.

B. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DOMESTIC-WATER PACKAGED BOOSTER PUMPS

A. Install packaged booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

D. Support connected domestic-water piping so weight of piping is not supported by packaged booster pumps.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic-water piping to packaged booster pumps. Install suction and discharge pipe equal to

or greater than size of system suction and discharge [**headers**][**piping**] .

1. Install shutoff valves on piping connections to packaged booster-pump suction and discharge [**headers**][**piping**] . Install ball, butterfly, or gate valves same size as suction and discharge [**headers**][**piping**] . Comply with requirements for general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Install union, flanged, or grooved-joint connections on suction and discharge [**headers**][**piping**] at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
3. Install valved bypass, same size as and between piping, at connections to packaged booster-pump suction and discharge [**headers**][**piping**] . Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
4. Install flexible connectors, same size as piping, on piping connections to packaged booster-pump suction and discharge [**headers**][**piping**] . Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
5. Where installing piping adjacent to packaged booster pumps, allow space for service and maintenance.

C. Install pressure gauges on feedwater-inlet and treated water outlet piping. Comply with requirements for pressure gauges specified in Section 220500 "Common Work Results for Plumbing."

1. Exception: Packaged booster pumps with factory-installed pressure gauges.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections: Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

1. Perform visual and mechanical inspection.
2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.9 ADJUSTING

A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within [**12**] months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to [**two**] visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner’s maintenance personnel to adjust, operate, and maintain booster pumps.

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SECTION 22 11 23 23 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal pumps, in-line, sealless.
2. Centrifugal pumps, horizontally mounted, in-line, separately coupled.
3. Centrifugal pumps, horizontally mounted, in-line, close-coupled.
4. Centrifugal pumps, vertically mounted, in-line, close-coupled.

B. Related Requirements:

1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.
2. Section 331113 "Potable Water Supply Wells" for well pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For pump controls.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which pumps will be attached.
2. Size and location of initial access modules for acoustical tile.

B. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality Control Reports: For specified tests and inspections.

D. Qualification Statements: For testing agency and factory-authorized service representative.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Authorized service representative who is trained and approved by manufacturer to perform [**manufacturer's field services**][**and**][**startup services**] .

B. Testing Agency Qualifications: An independent agency qualified to perform specified field tests.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF/ANSI 61 and NSF/ANSI/CAN 372.

D. Seismic Performance: Inline, domestic-water pumps to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."

2. Component Importance Factor: [**1.5**][**1.0**] .

2.2 CENTRIFUGAL PUMPS

A. Centrifugal Pumps, In-Line, Sealless:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Flo Fab Inc**]
b. [**GRUNDFOS CBS Inc.**]
c. [**Taco Comfort Solutions**]
d. [**WILO USA LLC - WILO Canada Inc.**]

2. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

3. Capacities and Characteristics:

a. Pump Control: [**Pressure switch**][**Thermostat**][**Timer**] .
b. Electrical Characteristics:

1) Volts: [**120**] V.
2) Phase: [**Single**] phase.
3) Hertz: [**60**] Hz.

4. Pump Construction:

a. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
b. Minimum Working Pressure: [**125 psig (860 kPa)**].
c. Maximum Continuous Operating Temperature: [**220 deg F (104 deg C)**].
d. Casing: [**Cast iron**][**Bronze**][**Stainless steel**] , with threaded or companion-flange connections.
e. Impeller: [**Plastic**][**composite**][**stainless steel**] .
f. Motor: [**Single**][**Three**] speed.

B. Centrifugal Pumps, Horizontally Mounted, In-Line, Separately Coupled:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Bell & Gossett; a Xylem brand**]
b. [**MEPCO, LLC.**]
c. [**Taco Comfort Solutions**]
d. [**Thrush Co. Inc.**]

2. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.

3. Capacities and Characteristics:

a. Pump Control: [**Pressure switch**][**Thermostat**][**Timer**] .
b. Electrical Characteristics:

1) Volts: [**120**][**240**] V.
2) Phases: [**Single**][**Three**] phase.
3) Hertz: [**60**] Hz.

4. Pump Construction:

a. Casing:

1) Radially split [**bronze**][**cast iron**][**stainless steel**] with threaded companion-flange connections for pumps with **NPS 2 (DN 50)** pipe connections and flanged connections for pumps with **NPS 2-1/2 (DN 65)** pipe connections.
2) Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
3) Gauge port tappings at suction and discharge nozzles.

b. Impeller: [**Bronze**][**stainless steel**] , statically and dynamically balanced, closed, and keyed to shaft.
c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
d. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
e. Seal: Mechanical, with [**carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket**].
f. Bearings: [**Grease-lubricated**][**permanently lubricated**] ball type.
g. Minimum Working Pressure: [**125 psig (860 kPa)**][**175 psig (1200 kPa)**].
h. Continuous Operating Temperature: [**200 deg F (93 deg C)**].

5. Motor: Single speed, with permanently lubricated ball bearings; and [**resiliently**][**rigidly**] mounted to pump casing.

C. Centrifugal Pumps, Horizontally Mounted, In-Line, Close-Coupled:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Alyan Pump Company**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**MEPCO, LLC.**]
d. [**Pentair Aurora; Pentair Pump Group**]
e. [**Taco Comfort Solutions**]
f. [**Thrush Co. Inc.**]

2. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

3. Capacities and Characteristics:

a. Pump Control: [**Pressure switch**][**Thermostat**][**Timer**] .
b. Electrical Characteristics:

1) Volts: [**120**][**240**] V.
2) Phases: [**Single**][**Three**] phase.
3) Hertz: [**60**] Hz.

4. Pump Construction:

   a. Casing:

      1) Radially split [**bronze**][**brass**][**cast iron**] with threaded companion-flange connections for pumps with **NPS 2 (DN 50)** pipe connections and flanged connections for pumps with **NPS 2-1/2 (DN 65)** pipe connections.
      2) Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
      3) Gauge port tappings at suction and discharge nozzles.

   b. Impeller: [**Bronze**][**brass**] , statically and dynamically balanced, closed, and keyed to shaft.
   c. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
   d. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
   e. Seal: Mechanical, with [**carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket**].
   f. Bearings: [**Grease-lubricated**][**permanently lubricated**] ball type.
   g. Minimum Working Pressure: [**175 psig (1200 kPa)**].
   h. Continuous Operating Temperature: [**225 deg F (107 deg C)**].

5. Motor: Single speed, with grease-lubricated ball bearings; [**resiliently**][**rigidly**] mounted to pump casing.

D. Centrifugal Pumps, Vertically Mounted, In-Line, Close-Coupled:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Alyan Pump Company**]
   b. [**Armstrong Fluid Technology**]
   c. [**Bell & Gossett; a Xylem brand**]
   d. [**Flo Fab Inc**]
   e. [**GRUNDFOS CBS Inc.**]
   f. [**MEPCO, LLC.**]
   g. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
   h. [**Pentair Aurora; Pentair Pump Group**]
   i. [**Taco Comfort Solutions**]
   j. [**Thrush Co. Inc.**]
   k. [**Weinman Division**]

2. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertically.

3. Capacities and Characteristics:

   a. Casing Material: [**Bronze**][**Cast iron**] .
   b. Impeller Material: [**ASTM B584, cast bronze**][**ASTM B584, cast bronze or stainless steel**][**Stainless steel**] .
   c. Minimum Operating Pressure: **175 psig (1200 kPa)**.
   d. Maximum Continuous Operating Temperature: **225 deg F (107 deg C)**.
   e. Pump Control: [**Pressure switch**][**Thermostat**][**Timer**] .
   f. Electrical Characteristics:

1) Volts: [**120**][**240**] V.
2) Phases: [**Single**][**Three**] phase.
3) Hertz: [**60**] Hz.

4. Pump Construction:

a. Casing: Radially split [**bronze**][**cast or ductile iron**] , with wear rings and threaded companion-flange connections for pumps with **NPS 2 (DN 50)** pipe connections and flanged connections for pumps with **NPS 2-1/2 (DN 65)** pipe connections. [**Include pump manufacturer's base attachment for mounting pump on concrete base.**]
b. Impeller: [**Bronze**][**brass**][**stainless steel**] , statically and dynamically balanced, closed, and keyed to shaft.
c. Shaft and Shaft Sleeve: [**Steel**][**stainless-steel**] shaft, with copper-alloy shaft sleeve.
d. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
e. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
f. Bearings: Oil-lubricated; bronze-journal or ball type.
g. Minimum Working Pressure: [**175 psig (1200 kPa)**].
h. Continuous Operating Temperature: [**225 deg F (107 deg C)**].

5. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Pressure Switches: Electric, adjustable for control of [**water-supply**] pump.

1. Type: Water-immersion pressure sensor, for installation in piping.
2. Enclosure: NEMA 250, [**Type 4X**].
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: [**24 V ac**][**120 V ac**].

B. Thermostats: Electric; adjustable for control of [**hot-water circulation**] pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: [**50 to 125 deg F (10 to 52 deg C)**][**65 to 200 deg F (18 to 93 deg C)**][**100 to 240 deg F (38 to 116 deg C)**].
3. Enclosure: NEMA 250, [**Type 4X**].
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: [**24 V ac**][**120 V ac**].
7. Settings: Start pump at [**105 deg F (41 deg C)**][**110 deg F (43 deg C)**][**115 deg F (46 deg C)**] and stop pump at [**120 deg F (49 deg C)**][**125 deg F (52 deg C)**].

C. Timers: Electric, for control of [**hot-water circulation**] pump.

1. Type: Programmable, [**seven-day**] clock with manual override on-off switch.
2. Enclosure: NEMA 250, [**Type 1**], suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: [**24 V ac**][**120 V ac**].
6. Programmable Sequence of Operation: [**Up to two on-off cycles each day for seven days**].

D. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.

1. Type: Adjustable time-delay relay.
2. Range: Up to five minutes.
3. Setting: Five minutes.
4. Enclosure: NEMA 250, [**Type 4X**].
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Power Requirement: [**24 V ac**][**120 V ac**].
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation, plus maximum five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 INSTALLATION OF CENTRIFUGAL PUMPS

A. Comply with ANSI/HI 14.1-14.2.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Pump Mounting:

1. Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using vibration isolation type and deflection as specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**] Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**] Fabricate brackets or supports as required.

2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

E. Install pressure switches in water-supply piping.

F. Install thermostats in hot-water return piping.

G. Install timers [**on wall in engineer's office**].

H. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
c. Vertically mounted, in-line, close-coupled centrifugal pumps.
d. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

1. Install pressure gauge [**and snubber**] at suction of each pump and pressure gauge [**and snubber**] at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220500 "Common Work Results for Plumbing."

3.4 INSTALLATION OF CONTROLS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. the Owner will engage a qualified testing agency to perform tests and inspections.

2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation, as directed by the Owner.

1. Extent of inspection is limited to [**three**] locations of straight pipe, [**three**] locations of threaded fittings, [**three**] locations of welded fittings, [**two**] locations of threaded strainers, [**two**] locations of welded strainers, [**three**] locations of threaded valves, and [**three**] locations of flanged valves for each pipe service defined in "Piping Insulation Schedule, General" Article.

2. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set [**pressure switches,**][**thermostats,**][**timers,**][**and**][**time-delay relays**] for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.

10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended in writing by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23 23

SECTION 22 11 23 23A - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Close-coupled, end-suction centrifugal pumps.
3. Separately coupled, horizontally mounted, in-line centrifugal pumps.
4. Separately coupled, vertically mounted, in-line centrifugal pumps.
5. Separately coupled, base-mounted, end-suction centrifugal pumps.
6. Separately coupled, base-mounted, double-suction centrifugal pumps.
7. Separately coupled, vertically mounted, double-suction centrifugal pumps.
8. Separately coupled, vertically mounted, turbine centrifugal pumps.
9. Wet-rotor pumps.
10. Automatic condensate pump units.

1.2 DEFINITIONS

A. ECM: Electronically commutated motor.

B. EPDM: Ethylene propylene diene monomer.

C. EPR: Ethylene propylene rubber.

D. FKM: Fluoroelastomer polymer.

E. HI: Hydraulic Institute.

F. NBR: Nitrile rubber or Buna-N.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump.

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For each pump.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

    a. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.
    b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: [**One**]<**Insert number**> mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**].

C. Seismic Performance: Pumps shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Crane Pumps & Systems**]
5. [**Flowserve Corporation**]
6. [**GRUNDFOS CBS Inc.**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Patterson Pump Company; a Gorman-Rupp company**]
11. [**Peerless Pump Company**]
12. [**Taco Comfort Solutions**]
13. [**Thrush Co. Inc.**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Crane Pumps & Systems**]
5. [**Flowserve Corporation**]
6. [**GRUNDFOS CBS Inc.**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Patterson Pump Company; a Gorman-Rupp company**]
11. [**Peerless Pump Company**]
12. [**Taco Comfort Solutions**]
13. [**Thrush Co. Inc.**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

E. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet[**, replaceable**

bronze wear rings,] and threaded [**companion-flange**][**union-end**] connections.

2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft Sleeve: [**Bronze**][**Type 304 stainless steel**].
4. Pump Stub Shaft: [**Type 304**][**Type 316**] stainless steel.
5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> rubber bellows and gasket. Include water slinger on shaft between motor and seal.
6. Seal Flushing: Flush, cool, and lubricate pump seal by directing pump discharge water to flow over the seal.

F. Shaft Coupling: Rigid, axially-split spacer coupling to allow service of pump seal without disturbing pump or motor.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure : [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

    a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: <**Insert value**> A.
    e. Minimum Circuit Ampacity: <**Insert value**> A.
    f. Maximum Overcurrent Protection: <**Insert value**> A.

2.3 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**GRUNDFOS CBS Inc.**]
8. [**ITT Corporation**]
9. [**Lancaster Pump**]
10. [**Mepco, LLC**]
11. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
12. [**Patterson Pump Company; a Gorman-Rupp company**]
13. [**Peerless Pump Company**]
14. [**Scot Pump; a division of Ardox Corporation**]
15. [**Taco Comfort Solutions**]
16. [**Thrush Co. Inc.**]
17. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**GRUNDFOS CBS Inc.**]
8. [**ITT Corporation**]
9. [**Lancaster Pump**]
10. [**Mepco, LLC**]
11. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
12. [**Patterson Pump Company; a Gorman-Rupp company**]
13. [**Peerless Pump Company**]
14. [**Scot Pump; a division of Ardox Corporation**]
15. [**Taco Comfort Solutions**]
16. [**Thrush Co. Inc.**]
17. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

E. Pump Construction:

1. Casing: Radially split, cast iron, with[**replaceable bronze wear rings,**] drain plug at bottom and air vent at top of volute, threaded gauge tappings at inlet and outlet, and [**threaded companion-flange**][**flanged**] connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft Sleeve: [**Bronze**][**Type 304 stainless steel**].
4. Pump Stub Shaft: [**Type 304**][**Type 316**] stainless steel.
5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a

stainless steel spring, and [**NBR**][**EPDM**][**FKM**] bellows and gasket. Include water slinger on shaft between motor and seal.

F. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

G. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.4 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Fluid Technology**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**Flowserve Corporation**]
4. [**ITT Corporation**]
5. [**Mepco, LLC**]
6. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
7. [**Scot Pump; a division of Ardox Corporation**]
8. [**Taco Comfort Solutions**]
9. [**Thrush Co. Inc.**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Armstrong Fluid Technology**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**Flowserve Corporation**]
4. [**ITT Corporation**]
5. [**Mepco, LLC**]
6. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
7. [**Scot Pump; a division of Ardox Corporation**]
8. [**Taco Comfort Solutions**]
9. [**Thrush Co. Inc.**]
10. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

E. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, and threaded [**companion-flange**][**union-end**] connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Carbon steel, with copper-alloy shaft sleeve**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.
5. Pump Bearings: [**Permanently lubricated ball bearings**][**Grease lubricated ball bearings**].

F. Shaft Coupling: [**Molded-rubber insert with interlocking spider**][**Interlocking frame with interconnecting springs**] capable of absorbing vibration.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure Type: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.

7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

    a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: <**Insert value**> A.
    e. Minimum Circuit Ampacity: <**Insert value**> A.
    f. Maximum Overcurrent Protection: <**Insert value**> A.

2.5 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Fluid Technology**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**Crane Pumps & Systems**]
4. [**Flowserve Corporation**]
5. [**ITT Corporation**]
6. [**Mepco, LLC**]
7. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
8. [**Patterson Pump Company; a Gorman-Rupp company**]
9. [**Peerless Pump Company**]
10. [**Taco Comfort Solutions**]
11. [**Thrush Co. Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong Fluid Technology**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**Crane Pumps & Systems**]
4. [**Flowserve Corporation**]
5. [**ITT Corporation**]
6. [**Mepco, LLC**]
7. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
8. [**Patterson Pump Company; a Gorman-Rupp company**]
9. [**Peerless Pump Company**]
10. [**Taco Comfort Solutions**]
11. [**Thrush Co. Inc.**]
12. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

E. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet[**, replaceable bronze wear rings,**] and threaded [**companion-flange**][**union-end**] connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Carbon steel, with copper-alloy shaft sleeve**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.

F. Shaft Coupling: [**Molded-rubber insert with interlocking spider**][**Interlocking frame with interconnecting springs**] capable of absorbing vibration.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

    a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: <**Insert value**> A.
    e. Minimum Circuit Ampacity: <**Insert value**> A.
    f. Maximum Overcurrent Protection: <**Insert value**> A.

2.6 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]

4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Peerless Pump Company**]
11. [**Scot Pump; a division of Ardox Corporation**]
12. [**Taco Comfort Solutions**]
13. [**Thrush Co. Inc.**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Peerless Pump Company**]
11. [**Scot Pump; a division of Ardox Corporation**]
12. [**Taco Comfort Solutions**]
13. [**Thrush Co. Inc.**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump with flexible shaft coupling as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

E. Pump Construction:

1. Casing: Radially split, cast iron, with[**replaceable bronze wear rings,**] threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and [**threaded companion-flange**][**flanged**] connections.[**Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring realignment of pump and motor shaft.**]
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Carbon steel, with copper-alloy shaft sleeve**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.
5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

F. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. [**Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor**][**EPDM coupling sleeve for variable-speed applications**].

G. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

H. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

I. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

J. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.7 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]

7. [**GRUNDFOS CBS Inc.**]
8. [**ITT Corporation**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Patterson Pump Company; a Gorman-Rupp company**]
11. [**Peerless Pump Company**]
12. [**Scot Pump; a division of Ardox Corporation**]
13. [**Taco Comfort Solutions**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**GRUNDFOS CBS Inc.**]
8. [**ITT Corporation**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Patterson Pump Company; a Gorman-Rupp company**]
11. [**Peerless Pump Company**]
12. [**Scot Pump; a division of Ardox Corporation**]
13. [**Taco Comfort Solutions**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

E. Pump Construction:

1. Casing: [**Radially**][**Horizontally**] split, cast iron, with[**replaceable bronze wear rings,**] threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, [**Class 125**][**Class 250**] flanges.[**Casing supports shall allow removal and replacement of impeller without disconnecting piping.**]
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Type 304**][**Type 316**] stainless steel.
4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.
5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

F. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. [**Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor**][**EPDM coupling sleeve for variable-speed applications**].

G. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

H. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

I. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

J. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.8 SEPARATELY COUPLED, VERTICALLY MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Flowserve Corporation**]
6. [**GRUNDFOS CBS Inc.**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Peerless Pump Company**]
11. [**Pentair Water Commercial Pool and Aquatics**]
12. [**Taco Comfort Solutions**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Flowserve Corporation**]
6. [**GRUNDFOS CBS Inc.**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Peerless Pump Company**]
11. [**Pentair Water Commercial Pool and Aquatics**]
12. [**Taco Comfort Solutions**]
13. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

E. Pump Construction:

1. Casing: Radially split, cast iron, with[**replaceable bronze wear rings,**] threaded gauge tappings at inlet and outlet, drain plug at bottom of volute, mounting support, and ASME B16.1, [**Class 125**][**Class 250**] flanges.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Type 304 stainless steel**][**Type 316 stainless steel**]<**Insert material**>.
4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.
5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

F. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

    a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: <**Insert value**> A.
    e. Minimum Circuit Ampacity: <**Insert value**> A.
    f. Maximum Overcurrent Protection: <**Insert value**> A.

2.9 SEPARATELY COUPLED, VERTICALLY MOUNTED, TURBINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Flowserve Corporation**]
3. [**Peerless Pump Company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Flowserve Corporation**]
3. [**Peerless Pump Company**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, [**single-stage**][**multistage**], centrifugal, impeller-between-bearings, end-suction pump as defined in HI 2.1-2.2 and HI 2.3; designed for installation with pump and motor shafts mounted vertically and projecting into a sump.

E. Pump Construction:

1. Pump Bowl: Cast iron, with [**cone**][**basket**] strainer[**, replaceable bronze wear ring,**] and suction bell.[**Water passages of intermediate bowls shall be coated with porcelain enamel.**]
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Carbon**][**Type 304 stainless**][**Type 316 stainless**] steel sized in accordance with manufacturer's written instructions.
4. Pump Bearings: Water-lubricated bronze and rubber sleeve bearings in cast-iron housing.
5. Pump Column: ASTM A53/A53M, Grade B steel pipe.
6. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**] bellows and gasket. Include water

slinger on shaft between motor and seal.

7. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

F. Shaft Coupling: Keyed with locking collets.

G. Discharge Head: ASME B16.1, [**Class 125**][**Class 250**] discharge flange with threaded gauge tapping. Top of discharge head shall have a registered fit to accurately locate the driver.

H. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

I. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Minimum Static Head: <**Insert feet (kPa)**>.
4. Maximum Operating Pressure: [**175 psig (1204 kPa)**]<**Insert value**>.
5. Maximum Continuous Operating Temperature: [**200 deg F (93 deg C)**]<**Insert temperature**>.
6. Outlet Size: <**Insert NPS (DN)**>.
7. Impeller Size: <**Insert inches (mm)**>.
8. Motor Speed: <**Insert rpm**>.
9. Motor Horsepower: <**Insert value**>.
10. Electrical Characteristics:

a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.10 WET-ROTOR PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Fluid Technology**]
2. [**Flowserve Corporation**]
3. [**GRUNDFOS CBS Inc.**]
4. [**ITT Corporation**]
5. [**Taco Comfort Solutions**]

6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong Fluid Technology**]
2. [**Flowserve Corporation**]
3. [**GRUNDFOS CBS Inc.**]
4. [**ITT Corporation**]
5. [**Taco Comfort Solutions**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, wet-rotor pump. Pump and motor to form an integral unit with bearings lubricated by the pumped liquid.

E. Pump Construction:

1. Body: [**100 percent lead-free bronze**][**Type 304 stainless steel**][**Cast iron**].
2. Impeller: [**Polypropylene**][**Noryl**][**Type 304 stainless steel**].
3. Pump Shaft: [**Ceramic**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Bearings. Double-sintered carbon.

F. Motor: [**Single**][**Three**][**Variable**] speed.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

    a. Efficiency: Premium Efficiency.
    b. NEMA Design: <**Insert designation**>.
    c. Service Factor: <**Insert value**>.

3. Integral pump motor variable-speed control.
4. ECM.

G. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**150 psig (1132 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**230 deg F (111 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

    a. Volts: [**120**]<**Insert value**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: <**Insert value**> A.
    e. Minimum Circuit Ampacity: <**Insert value**> A.

f. Maximum Overcurrent Protection: <**Insert value**> A.

2.11 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Beckett Corporation**]
2. [**Crane Pumps & Systems**]
3. [**GRUNDFOS CBS Inc.**]
4. [**Hartell Pumps; Milton Roy**]
5. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Beckett Corporation**]
2. [**Crane Pumps & Systems**]
3. [**GRUNDFOS CBS Inc.**]
4. [**Hartell Pumps; Milton Roy**]
5. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pump units from single source from single manufacturer.

D. Description: Packaged units with corrosion-resistant pump, [**aluminum**][**plastic**] tank with cover, and automatic controls. Collects and removes condensate from fan coil units, air handling units, condensing boilers, and similar components. Include factory- or field-installed check valve and **72-inch- (1800-mm-)** minimum, electrical power cord with plug.

E. Capacities and Characteristics:

1. Tank Capacity: <**Insert gal (L)**>.
2. Pump Capacity: <**Insert gpm (L/s)**>.
3. Maximum Lift: <**Insert feet (m)**>.
4. Motor Horsepower: <**Insert value**>.
5. Electrical Characteristics:

a. Volts: [**120**]<**Insert value**> V.
b. Phase: Single.
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.12 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. [**175-psig (1204-kPa)**][**300-psig (2060-kPa)**] pressure rating, [**cast**][**ductile**]-iron body and end

cap, pump-inlet fitting.

3. Bronze 16-mesh wire startup and [**bronze**][**Type 304 stainless steel**] permanent strainers with **3/16-inch (4.8-mm) perforations and 51 percent open area)**.
4. [**Bronze**][**Carbon steel**][**Type 304 stainless steel**] straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. [**175-psig (1204-kPa)**][**300-psig (2060-kPa)**] pressure rating, [**cast**][**ductile**]-iron body, pump-discharge fitting.
3. Valve with multi-turn stem and memory stop to allow valve to be returned to its original position after shutoff.
4. Brass valve disc with EPDM rubber seat.
5. Type 304 stainless steel valve stem.
6. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
7. Brass gauge ports with integral check valve and orifice for flow measurement.

2.13 INTEGRAL PUMP MOTOR VARIABLE-SPEED CONTROLLERS

A. Where specified or scheduled, provide pumps with an integral pump motor speed controller.

1. Motor: Operates as constant- or variable-speed pump with speed regulated by an integrated variable-speed drive.
2. Integrated Pump Controller: Supports direct communication with the building management system (BMS) with built-in support for the following protocols: [**Modbus RTU**][**BACnet MS/TP**][**Metasys N2**].
3. Commissioning and pump set up access to pump controls via the following:

    a. A web interface (data exchange).
    b. A user interface located on the face of speed controller to adjust modes and mode values.
    c. An electronic display that reads real-time mode set values, flow, head, speed, and power and that locks out unauthorized adjustment of pump.

4. Provide electronics with "Auto" as factory default but slope of the proportional curve will automatically match the required system curve, constant pressure control (delta-p/c), variable differential pressure control (delta-p/v), constant curve duty (uncontrolled pump), and rpm regulation. RPM (speed) regulation can be accomplished by the following:

    a. Manual (via user interface or HTML).
    b. Remote via 0 to 10 V dc.
    c. Data protocol communications with the BMS.

5. Pump Electronics: Standard with multiple digital inputs and one external digital output to be available for additional mechanical room control and pump status monitoring.
6. Controller: Mounted on or adjacent to the motor. Provide enclosure rated to UL Type 12.
7. Electronically Protected Pumps: Rated for continuous duty and with built-in startup circuit. Provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.
8. Pump capable of being monitored continuously via integrated Internet link.
9. Integrated pump controller system to have the following features:

    a. Controller software shall be capable of sensorless control in variable-volume systems without need for pump-mounted (internal/external) or remotely mounted differential

pressure sensor.

b. Integrated Pump Controller Sensorless Control: Operates under Quadratic Pressure Control (QPC) to ensure that head reduction with reducing flow conforms to quadratic control curve.

c. Controller:

1) Minimum head of 40 percent of design duty head.
2) User-adjustable control mode settings and minimum/maximum head set points using built-in programming interface.

d. Controller Integrated Control Software:

1) Capable of controlling pump performance for non-overloading power at every point of operation.
2) Capable of maintaining flow rate data.

2.14 ELECTRONICALLY COMMUTATED MOTOR (ECM)

A. Provide pumps so they are specified or scheduled with ECM.

1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with [**HI 1.4**][**and**][**HI 2.4**].

B. Install pumps to provide access for periodic maintenance including removing motors, impellers,

couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Equipment Mounting for In-Line Pumps Suspended from Structure: Install in-line pumps with continuous-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**] of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.

C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

D. Comply with pump and coupling manufacturers' written instructions.

E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install [**check, shutoff, and throttling valves**][**check valve and throttling valve with memory stop**][**triple-duty valve**] on discharge side of pumps.

F. Install [**Y-type strainer**][**suction diffuser**] and shutoff valve on suction side of pumps.

1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

I. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.

b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Hydronic pumps will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 22 11 23 23A

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SECTION 22 13 00 00 - FACILITY GRAY-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel, pressure, water storage tank.
2. Steel, nonpressure, water storage tank.
3. Insulated, steel, water storage tanks.
4. Plastic, pressure, water storage tank.
5. Plastic, nonpressure, water storage tanks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for gray-water storage tanks.
2. Include rated capacities, operating characteristics, [**electrical characteristics,**]and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of <**Insert portion of Work**>.
4. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For facility gray-water storage tanks.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**manufacturer**][**fabricator**].

B. Seismic Qualification Certificates: For gray-water storage tanks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gray-water storage tanks to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Employ a qualified structural engineer to prepare calculations, Shop Drawings, and other structural data for fabrication and erection of surface water-storage tanks.

1. Engineering Responsibility: Preparation of data for surface water-storage tanks, accessories, specified appurtenances, and concrete supports and foundations, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforced Steel."

C. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design facility gray-water storage tanks.

B. Structural Performance: Surface water-storage tank, including structural reinforcement and foundation, shall be capable of withstanding the effects of dead and live gravity loads and winds of [**100 mph (161 km/h)**]<**Insert value**>.

C. Seismic Performance: Surface water-storage tank, including structural reinforcement and foundation, withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: [**1.5**][**1.0**].

D. Thermal Movements: Surface water-storage tank, including structural reinforcement and foundation, shall allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**]<**Insert temperature change**>.

E. Comply with AWWA D100, "Welded Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks."

F. Comply with AWWA D110, "Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks."

G. Comply with AWWA D110, "Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks."

H. Comply with AWWA D115, "Tendon-Prestressed Concrete Water Tanks."

I. Comply with AWWA D120, "Thermosetting Fiberglass-Reinforced Plastic Tanks."

2.2 STEEL, PRESSURE, WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**Green Boiler Technologies**]
8. [**GSW Water Heating**]
9. [**HESCO Bastion Ltd.**]
10. [**Lochinvar, LLC**]
11. [**Precision Boilers**]
12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**Green Boiler Technologies**]
8. [**GSW Water Heating**]
9. [**HESCO Bastion Ltd.**]
10. [**Lochinvar, LLC**]
11. [**Precision Boilers**]

12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with nontoxic welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

J. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

K. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.3 STEEL, NONPRESSURE, WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**RECO USA**]
4. [**Steel Tank and Fabricating Corporation (STAFCO)**]
5. [**Wood, John Co**]

6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**RECO USA**]
4. [**Steel Tank and Fabricating Corporation (STAFCO)**]
5. [**Wood, John Co**]
6. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], nonpressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: Steel, constructed with nontoxic welded joints.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.

G. Cover for Open Tank: [**Plastic**][**Steel, with lining same as or similar to tank lining and**] with shape that encloses top of tank.

H. Tappings: Factory-fabricated[**stainless**] steel, welded to tank.

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

I. Specialties and Accessories: Include tappings in tank and the following:

1. Vacuum relief valve.
2. Free air vent with insect screen.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

J. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

K. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

L. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.4 INSULATED, STEEL, WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**GSW Water Heating**]
3. [**HESCO Bastion Ltd.**]

4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Precision Boilers**]
7. [**PVI; A WATTS Brand**]
8. [**RBI**]
9. [**State Industries**]
10. [**Vaughn Thermal Corporation**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**GSW Water Heating**]
3. [**HESCO Bastion Ltd.**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Precision Boilers**]
7. [**PVI; A WATTS Brand**]
8. [**RBI**]
9. [**State Industries**]
10. [**Vaughn Thermal Corporation**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

C. Description: Steel, vertical, pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with nontoxic welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

J. Insulation: Factory-installed fiberglass or polyurethane foam; surrounding entire tank except connections and other openings; suitable for tank operating temperature; and complying with

ASHRAE/IES 90.1.

K. Jacket: Steel, with manufacturer's standard finish unless otherwise indicated.

2.5 PLASTIC, PRESSURE, WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]
3. <**Insert manufacturer's name**>

C. Description: FRP, vertical, pressure-rated tank with cylindrical sidewalls.

D. Construction: [**ASME code, composite FRP**][**Composite FRP**], [**contact-molded**][**or**][**filament-wound**], thermosetting-resin tank for [**100-psig (690-kPa)**][**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

E. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

F. Tappings: Factory-fabricated, FRP flanged-end nozzle.

1. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

G. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.

H. Vertical Tank Supports: Factory-fabricated steel legs or FRP skirt attached by FRP brackets to tank sidewall.

2.6 PLASTIC, NONPRESSURE, WATER STORAGE TANKS

A. FRP Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amprotec, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amprotec, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

3. Description: FRP, vertical, nonpressure-rated water tank.
4. Construction: [**ASTM D3299, filament-wound**][**or**][**ASTM D4097, contact-molded**] FRP.
5. Tappings: Factory-fabricated, FRP flanged-end nozzle.

a. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.

1) [**Exception: Tappings may be threaded FRP coupling integral with nozzle for connections for plastic piping.**]

b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting tank.

B. PE Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amprotec, Inc.**]
b. [**Assmann Corporation of America**]
c. [**Chem-Tainer Industries**]
d. [**Poly Processing Company**]
e. [**Premier Plastics Inc.**]
f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amprotec, Inc.**]
b. [**Assmann Corporation of America**]
c. [**Chem-Tainer Industries**]
d. [**Poly Processing Company**]

e. [**Premier Plastics Inc.**]
f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

3. Description: PE, vertical, flat-bottom, nonpressure-rated water tank.
4. Construction: ASTM D1998, molded PE.
5. Tappings: Factory-fabricated bulkhead fittings attached to tank.

a. NPS 2 (DN 50) and Smaller: With female thread.
b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting entire bottom of tank.

C. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.

D. Cover for Open Tank: Plastic, same as or similar to tank material and with shape that encloses top of tank.

E. Specialties and Accessories: Include tappings in tank and the following:

1. Vacuum relief valve.
2. Free air vent with insect screen.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

2.7 PAINT MATERIALS

A. Paint: Comply with AWWA D102.

B. Primer: Tank fabricator's standard epoxy-polyamide paint.

C. Tank Shell Exterior Intermediate Paint: Tank fabricator's standard, two-component epoxy paint compatible with prime and finish paint. Intermediate coat shall have a slight color contrast with finish coat.

D. Tank Shell Exterior Finish Paint: Tank fabricator's standard urethane paint.

1. Color: [**As selected by Owner from tank manufacturer's paint chart**]<**Insert color**>.

2.8 SHOP PAINTING

A. Tank Shell Exterior Finish Coat: Factory coating according to AWWA D103.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices

needing servicing are accessible.

1. Install horizontal tanks on [**concrete piers and factory-fabricated**][**fabricated steel supports and**] saddles.

B. Vertical Water Storage Tanks:

1. Install on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Anchor tank supports and tanks to substrate.

1. Use steel or FRP straps over or around plastic tanks.

D. Install tank seismic restraints.

E. Install thermometers and pressure gages on water storage tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220500 "Common Work Results for Plumbing."

F. Install the following devices on tanks:

1. Pressure relief valves.
2. Temperature and pressure relief valves.
3. Vacuum relief valves.
4. Tank vents on nonpressure tanks.
5. Connections to accessories.

G. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Tank Weld Test: Use radiographic method according to AWWA D100. Repair failures and retest.
2. Leak Test, AWWA D100: Comply with AWWA D100[**and NFPA 22**]. Fill tanks with water and test for leaks after installation. Repair leaks and retest until no leaks exist.

    a. Water will be furnished by Owner.

3. Leak Test: Comply with [**AWWA D110**][**AWWA D115**][**and NFPA 22**]. Fill tanks with water and test for leaks after installation. Repair leaks and retest until no leaks exist.

    a. Water will be furnished by Owner.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Water storage tanks will be considered defective if they do not pass test and inspections.

C. Prepare test and inspection reports.

END OF SECTION 22 13 00 00

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Task	Specification	Specification Description
22 13 13 00	22 13 00 00	Facility Gray-Water Storage Tanks

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SECTION 22 13 16 00 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Stainless steel drainage pipe and fittings.
5. Ductile-iron pipe and fittings.
6. Copper tube and fittings.
7. ABS pipe and fittings.
8. PVC pipe and fittings.
9. Specialty pipe fittings.
10. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
2. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.
3. Section 333115 "Site Sanitary Sewerage Piping" for sanitary sewerage piping and structures outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: [**10 ft. head of water (30 kPa head of water)**]<**Insert pressure**>.
2. Waste, Force-Main Piping: [**50 psig (345 kPa)**][**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**>.

B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].

C. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A74, [**service**][**and**][**extra-heavy**] cast iron.

D. Gaskets: ASTM C564, rubber.

E. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A888 or CISPI 301.

D. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Conine Manufacturing Co., Inc**]
    b. [**SE Sovent**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Conine Manufacturing Co., Inc**]
    b. [**SE Sovent**]
    c. <**Insert manufacturer's name**>

E. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

3. Standards: ASTM C1277 and CISPI 310.
4. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AB & I Foundry; a part of the McWane family of companies**]
    b. [**ANACO-Husky; a part of the McWane family of companies**]
    c. [**Charlotte Pipe and Foundry Company**]
    d. [**Clamp-All Corp**]
    e. [**Dallas Specialty & Mfg. Co.**]
    f. [**Ideal Tridon Group**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**AB & I Foundry; a part of the McWane family of companies**]
    b. [**ANACO-Husky; a part of the McWane family of companies**]
    c. [**Charlotte Pipe and Foundry Company**]
    d. [**Clamp-All Corp**]
    e. [**Dallas Specialty & Mfg. Co.**]
    f. [**Ideal Tridon Group**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

3. Standards: ASTM C1277 and ASTM C1540. <**Insert standard**>.
4. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    1. [**U.S. Steel**]
    2. [**Wheatland Tube; Zekelman Industries**]
    3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    1. [**U.S. Steel**]
    2. [**Wheatland Tube; Zekelman Industries**]
    3. <**Insert manufacturer's name**>

C. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, standard-weight cast iron. Include square-cut-grooved or threaded ends matching joining method.

D. Cast-Iron Drainage Fittings: [**Galvanized;**]ASME B16.12, threaded.

E. Steel Pipe Pressure Fittings:

1. Steel Pipe Nipples: [**Galvanized;**]ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: [**Galvanized;**]ASME B16.4, Class 125, standard pattern.

F. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Smith-Cooper International**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Smith-Cooper International**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

3. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536, ductile-iron castings; ASTM A47/A47M, malleable-iron castings; ASTM A234/A234M, forged steel fittings; or ASTM A106/A106M, steel pipes with dimensions matching ASTM A53/A53M, steel pipe, and complying with AWWA C606 for grooved ends.
4. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

2.6 STAINLESS STEEL DRAINAGE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anvil; an ASC Engineered Solution**]
2. [**BLÜCHER; A Watts Water Technologies Company**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anvil; an ASC Engineered Solution**]
2. [**BLÜCHER; A Watts Water Technologies Company**]
3. <**Insert manufacturer's name**>

C. Description: Comply with requirements of ASME A112.3.1 drainage pattern.

D. Material: [**Type 304 stainless steel**][**Type 316L stainless steel**][**Type 304 or 316L stainless steel**].

E. Pipe Construction: Seamless.

F. Internal Sealing Rings: [**EPDM**][**NBR**]<**Insert material**>[**, marked or color-coded for the application**].

G. Joints: Single or double, socket and spigot ends.

2.7 DUCTILE-IRON PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Cast Iron Pipe Company**]
2. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
3. [**McWane Ductile; a part of the McWane family of companies**]
4. [**U.S. Pipe**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Cast Iron Pipe Company**]
2. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
3. [**McWane Ductile; a part of the McWane family of companies**]
4. [**U.S. Pipe**]
5. <**Insert manufacturer's name**>

C. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

E. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends in accordance with AWWA C606.

F. Ductile-Iron, Grooved-End Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   c. [**Smith-Cooper International**]
   d. [**Star Pipe Products**]
   e. [**Victaulic Company**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   c. [**Smith-Cooper International**]
   d. [**Star Pipe Products**]
   e. [**Victaulic Company**]
   f. <**Insert manufacturer's name**>

3. Grooved-End, Ductile-Iron Fittings: ASTM A536, ductile-iron castings, with dimensions matching AWWA C110/A 21.10, ductile-iron pipe or AWWA C153/A 21.53, ductile-iron fittings, and complying with AWWA C606 for grooved ends.
4. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys, EPDM-rubber center-leg gasket suitable for hot and cold water, and bolts and nuts.

2.8 COPPER TUBE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Cambridge-Lee Industries, LLC**]
3. [**Cerro Flow Products, LLC**]
4. [**Wieland Copper Products, LLC**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Cambridge-Lee Industries, LLC**]
3. [**Cerro Flow Products, LLC**]
4. [**Wieland Copper Products, LLC**]
5. <**Insert manufacturer's name**>

C. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

D. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

E. Hard Copper Tube: **ASTM B88, Type L and Type M (ASTM B88M, Type B and Type C)**, water tube, drawn temper.

F. Soft Copper Tube: **ASTM B88, Type L (ASTM B88M, Type B)**, water tube, annealed temper.

G. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

H. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

I. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.9 ABS PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Charlotte Pipe and Foundry Company**]
2. [**JM Eagle**]
3. [**Royal Building Products, a Westlake Company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Charlotte Pipe and Foundry Company**]
2. [**JM Eagle**]
3. [**Royal Building Products, a Westlake Company**]
4. <**Insert manufacturer's name**>

C. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic

drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

D. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

E. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

F. ABS Socket Fittings: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

G. Solvent Cement: ASTM D2235.

1. Product Data: Verify ABS solvent cement has a VOC content of 325 g/L or less.
2. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.10 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**GF Piping Systems**]
4. [**JM Eagle**]
5. [**National Pipe and Plastic, Inc. (Oldcastle)**]
6. [**North America Pipe Corporation**]
7. [**Rocky Mountain Colby Pipe Company**]
8. [**Silver-line Plastics**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**GF Piping Systems**]
4. [**JM Eagle**]
5. [**National Pipe and Plastic, Inc. (Oldcastle)**]
6. [**North America Pipe Corporation**]
7. [**Rocky Mountain Colby Pipe Company**]
8. [**Silver-line Plastics**]
9. <**Insert manufacturer's name**>

C. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

D. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

E. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.

F. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

G. Adhesive Primer: ASTM F656.

1. Product Data: Verify adhesive primer has a VOC content of 550 g/L or less.
2. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

H. Solvent Cement: ASTM D2564.

1. Product Data: Verify PVC welding solvent cement has a VOC content of 510 g/L or less.

2.11 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) [**Plastic Oddities**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) [**Plastic Oddities**]
5) <**Insert manufacturer's name**>

c. Standard: ASTM C1173.
d. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. End Connections: Same size as and compatible with pipes to be joined.
f. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Cascade Waterworks Mfg. Co.**]
2) [**Mission Rubber Company, LLC**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Cascade Waterworks Mfg. Co.**]
2) [**Mission Rubber Company, LLC**]
3) <**Insert manufacturer's name**>

c. Standard: ASTM C1460.
d. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**Cascade Waterworks Mfg. Co.**]
3) [**EBAA Iron Sales, Inc.**]
4) [**Ford Meter Box Company, Inc. (The)**]
5) [**JCM Industries, Inc**]
6) [**Romac Industries, Inc.**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**Cascade Waterworks Mfg. Co.**]
3) [**EBAA Iron Sales, Inc.**]
4) [**Ford Meter Box Company, Inc. (The)**]
5) [**JCM Industries, Inc**]
6) [**Romac Industries, Inc.**]
7) <**Insert manufacturer's name**>

c. Standard: AWWA C219.
d. Description: Metal sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
e. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].
f. Gasket Material: Natural or synthetic rubber.
g. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**A.Y. McDonald Mfg. Co.**]
2) [**Capitol Manufacturing Company**]
3) [**GF Piping Systems: Georg Fischer LLC**]
4) [**HART Industrial Unions, LLC**]
5) [**Jomar Valve**]
6) [**Matco-Norca**]
7) [**WATTS; A Watts Water Technologies Company**]
8) [**Wilkins**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**A.Y. McDonald Mfg. Co.**]
2) [**Capitol Manufacturing Company**]
3) [**GF Piping Systems: Georg Fischer LLC**]
4) [**HART Industrial Unions, LLC**]
5) [**Jomar Valve**]
6) [**Matco-Norca**]
7) [**WATTS; A Watts Water Technologies Company**]
8) [**Wilkins**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

c. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: [125 psig (860 kPa) **minimum at** 180 deg F (82 deg C)][150 psig (1035 kPa)][250 psig (1725 kPa)]<**Insert pressure**>.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Capitol Manufacturing Company**]
2) [**GF Piping Systems: Georg Fischer LLC**]
3) [**Matco-Norca**]
4) [**WATTS; A Watts Water Technologies Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Capitol Manufacturing Company**]
2) [**GF Piping Systems: Georg Fischer LLC**]
3) [**Matco-Norca**]
4) [**WATTS; A Watts Water Technologies Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

c. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: [125 psig (860 kPa) **minimum at** 180 deg F (82 deg C)][150 psig (1035 kPa)][175 psig (1200 kPa)][300 psig (2070 kPa)]<**Insert pressure**>.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advance Products & Systems, LLC**]
2) [**CALPICO, Inc.**]
3) [**GF Piping Systems: Georg Fischer LLC**]
4) [**GPT; a division of EnPRO Industries**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**Advance Products & Systems, LLC**]
2) [**CALPICO, Inc.**]
3) [**GF Piping Systems: Georg Fischer LLC**]
4) [**GPT; a division of EnPRO Industries**]
5) <**Insert manufacturer's name**>

c. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**>.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Elster Perfection; Honeywell**]
3) [**Matco-Norca**]
4) [**Precision Plumbing Products**]
5) [**Victaulic Company**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Elster Perfection; Honeywell**]
3) [**Matco-Norca**]
4) [**Precision Plumbing Products**]
5) [**Victaulic Company**]
6) <**Insert manufacturer's name**>

c. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert pressure and temperature**>.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.12 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: [**Linear low-density polyethylene film of 0.008-inch (0.20-mm)**][**or**][**high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)**] minimum thickness.

C. Form: [**Sheet**][**or**][**tube**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**].

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping **NPS 3 (DN 80)** and smaller; [**1**][**2**]<**Insert number**> percent downward in direction of flow for piping **NPS 4 (DN 100)** and larger.
2. Horizontal Sanitary Waste Piping: [**Two**]<**Insert number**> percent downward in direction of flow.
3. Vent Piping: [**One**]<**Insert number**> percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

O. Install steel piping in accordance with applicable plumbing code.

P. Install stainless steel piping in accordance with ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping in accordance with ASTM D2661.

S. Install aboveground PVC piping in accordance with ASTM D2665.

T. Install underground [**ABS**][**and**][**PVC**] piping in accordance with ASTM D2321.

U. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

V. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

W. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

X. Install force mains at elevations indicated.

Y. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

AA. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

BB. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

E. Join stainless steel pipe and fittings with gaskets in accordance with ASME A112.3.1.

F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

J. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

    a. Provide axial restraint for pipe and fittings [**5 inches (125 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    b. Provide rigid sway bracing for pipe and fittings [**4 inches (100 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    c. Provide rigid sway bracing for pipe and fittings [**5 inches (125 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: [**Unshielded**][**Shielded**], nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [**nipples**][**unions**].
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [**flanges**][**flange kits**][**nipples**].
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installation are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install [**gate**][**full-port ball**] valve for piping **NPS 2 (DN 50)** and smaller.
3. Install [**gate**]<**Insert type**> valve for piping **NPS 2-1/2 (DN 65)** and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.[**Use normally closed type unless otherwise indicated.**]
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in [**Section 220529 "Hangers and Supports for Plumbing Piping and Equipment"**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**].

1. Install [**carbon-steel**]<**Insert material**> pipe hangers for horizontal piping in noncorrosive environments.
2. Install [**stainless steel**][**fiberglass**] pipe hangers for horizontal piping in corrosive environments.
3. Install [**carbon-steel**]<**Insert material**> pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42 clamps.
6. Install individual, straight, horizontal piping runs:

a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for [**cast-iron**][**steel**][**stainless steel**][**and**][**copper**] soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [**ABS**][**and**][**PVC**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within **12 inches (300 mm)** of each fitting[**, valve,**] and coupling.

F. Support vertical runs of [**cast-iron**][**steel**][**stainless steel**][**and**][**copper**] soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of [**ABS**][**and**][**PVC**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves [**with cleanout cover flush with floor**][**in pit with pit cover flush with floor**]<**Insert description**>.
6. Comply with requirements for [**backwater valves**][**cleanouts**][**and**][**drains**] specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

a. Provide shutoff valve if indicated and union for each connection.
b. Use flanges instead of unions for connections **NPS 2-1/2 (DN 65)** and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than **10 ft. head of water (30 kPa head of water)**.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.

c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

   a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of **1 inch wg (250 Pa)**.
   b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
   c. Air pressure must remain constant without introducing additional air throughout period of inspection.
   d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

   a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials.

   a. Isolate test source and allow to stand for four hours.
   b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed Plastic Piping: Protect [**ABS**][**PVC**] plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:

1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings[**and hubless, single-stack aerator fittings**]; [**CISPI**][**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.
6. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings [**and hubless, single-stack aerator fittings**]; [**CISPI**][**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**][**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings gaskets, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, **Type M (Type C)**; copper pressure fittings; and soldered joints.

6. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**][**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:

1. [**Extra-heavy**][**Service**] cast-iron soil piping; [**gaskets; and gasketed**][**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**][**heavy-duty**][**cast-iron**] hubless-piping couplings; and coupled joints.
3. Stainless steel pipe and fittings, gaskets, and gasketed joints.
4. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. [**Extra-heavy**][**Service**], cast-iron soil piping; [**gaskets; and gasketed**][**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**][**heavy-duty**][**cast-iron**] hubless-piping couplings; coupled joints.
3. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) are to be the following:

1. Hard copper tube, **Type L (Type B)**; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) are to be the following:

1. Hard copper tube, **Type L (Type B)**; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller are to be the following:

1. [**Hard**][**Soft**] copper tube, **Type L (Type B)**; [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than **NPS 1-1/2 (DN 40)** and pressure transition coupling for **NPS 1-1/2 (DN 40)** and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger are to be the following:

1. Hard copper tube, **Type L (Type B)**; [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 22 13 16 00

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Task	Specification	Specification Description
22 13 16 00	07 63 00 00	Common Work Results for Fire Suppression
22 13 16 00	22 05 00 00	Common Work Results for Plumbing
22 13 16 00	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 16 00	22 14 13 00	Storm Drainage Piping
22 13 16 00	07 63 00 00a	Common Work Results for HVAC

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SECTION 22 13 19 00 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backwater valves, horizontal, cast iron.
2. Backwater valves, drain-outlet type.
3. Backwater valves, horizontal, plastic.
4. Cleanouts, cast iron, exposed.
5. Cleanouts, stainless steel, exposed.
6. Cleanouts, cast iron, exposed, floor mounted.
7. Cleanouts, stainless steel, exposed, floor mounted.
8. Cleanouts, cast iron, wall mounted.
9. Cleanouts, plastic, floor mounted.
10. Air-admittance valves, at fixture.
11. Air-admittance valves, stack mounted.
12. Air-admittance valves, wall box.
13. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 077200 "Roof Accessories" for preformed flashings.
3. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
4. Section 221323 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.
5. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
6. Section 224300 "Healthcare Plumbing Fixtures" for plaster sink interceptors.
7. Section 334200 "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

1.2 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.

B. EPDM: Ethylene propylene diene monomer.

C. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Frost-Resistant Vent Terminals: Show fabrication and installation details.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality Control Reports: For specified tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties.

PART 2 - PRODUCTS

2.1 ASSEMBLY REQUIREMENTS

A. Provide sanitary waste piping specialties bearing label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14 for plastic sanitary waste piping specialty components.

2.2 BACKWATER VALVES

A. Backwater Valves, Horizontal, Cast Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn; Zurn Elkay**]

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with [**bolted**][**threaded**] access check valve.
6. End Connections: [**Hub and spigot**][**hubless**] .
7. Check Valve: Removable bronze swing check, factory assembled or field modified to hang [**closed**][**open for airflow unless subject to backflow condition**] .
8. Extension: ASTM A74, Service Class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; in place of backwater valve cover.

B. Backwater Valves, Drain-Outlet Type :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]

b. [**Josam Company**]
c. [**WATTS; A Watts Water Technologies Company**]
d. [**Zurn; Zurn Elkay**]

2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze; made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

C. Backwater Valves, Horizontal, Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Endura; a Canplas Industries Company**]
b. [**IPS Corporation**]
c. [**NDS Inc**]
d. [**Oatey Co.**]
e. [**Plastic Oddities**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**Zurn; Zurn Elkay**]

2. Size: Same as connected piping.
3. Body: [**ABS**][**PVC**] .
4. Cover: Same material as body with threaded access to check valve.
5. Check Valve: Removable swing check.
6. End Connections: Socket type.

2.3 CLEANOUTS

A. Cleanouts, Cast Iron, Exposed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Tyler Pipe; a part of the McWane family of companies**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn; Zurn Elkay**]

2. Standard: ASME A112.36.2.
3. Size: Same as connected drainage piping.
4. Body Material: [**Hub-and-spigot, cast-iron soil pipe T-branch**][**Hubless, cast-iron soil pipe test tee**] as required to match connected piping.
5. Closure: [**Countersunk**][**raised-head**] , [**brass**][**cast-iron**][**plastic**] plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cleanouts, Stainless Steel, Exposed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**BLÜCHER; A Watts Water Technologies Company**]
   b. [**Josam Company**]
   c. [**Kusel Equipment Co**]
   d. [**Zurn Elkay Water Solutions**]

2. Standard: ASME A112.3.1.
3. Size: Same as connected drainage piping.
4. Body Material: Stainless steel tee with side cleanout as required to match connected piping.
5. Closure: Stainless steel plug with seal.

C. Cleanouts, Cast Iron, Exposed, Floor Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Sioux Chief Manufacturing Company, Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn; Zurn Elkay**]

2. Standard: ASME A112.36.2 for [**adjustable housing**][**cast-iron soil pipe with cast-iron ferrule**][**heavy-duty, adjustable housing**][**threaded, adjustable housing**] cleanout.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron.
5. Clamping Device: [**Not required**][**Required**] .
6. Outlet Connection: [**Inside caulk**][**Spigot**][**Threaded**] .
7. Closure: [**Brass plug with straight threads and gasket**][**Brass plug with tapered threads**][**Cast-iron plug**][**Plastic plug**] .
8. Adjustable Housing Material: [**Cast iron**][**Plastic**] with [**threads**][**setscrews or other device**] .
9. Frame and Cover Material and Finish: [**Nickel-bronze, copper alloy**][**Painted cast iron**][**Polished bronze**][**Rough bronze**][**Stainless steel**].
10. Frame and Cover Shape: [**Round**][**Square**].
11. Top-Loading Classification: [**Extra-Heavy**][**Heavy**][**Light**][**Medium**] Duty.
12. Riser: ASTM A74, [**Extra-Heavy**][**Service**] Class, cast-iron drainage pipe fitting and riser to cleanout.

D. Cleanouts, Stainless Steel, Exposed, Floor Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**BLÜCHER; A Watts Water Technologies Company**]
b. [**Josam Company**]
c. [**Kusel Equipment Co**]
d. [**Zurn; Zurn Elkay**]

2. Standards: ASME A112.3.1 [**; NSF listed**] .
3. Size: Same as connected branch.

4. Housing: [**Type 304**][**Type 316**] stainless steel.
5. Closure: [**Stainless steel with seal**][**Plastic plug**] .
6. Riser: ASTM A74, [**Extra-Heavy**][**Service**] Class, [**stainless steel**][**cast-iron**] drainage pipe fitting and riser to cleanout.
7. Body or Ferrule: Stainless steel.
8. Clamping Device: [**Not required**][**Required**] .
9. Outlet Connection: [**Inside caulk**][**Spigot**][**Threaded**][**Butt-weld**] .
10. Adjustable Housing Material: [**Cast iron**][**Plastic**] with [**threads**][**setscrews or other device**] .
11. Frame and Cover Material and Finish: Stainless steel.
12. Frame and Cover Shape: [**Round**][**Square**] .
13. Top-Loading Classification: [**Extra Heavy**][**Heavy**][**Light**][**Medium**] Duty.

E. Cleanouts, Cast Iron, Wall Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn; Zurn Elkay**]

2. Standard: ASME A112.36.2. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: [**Hub-and-spigot, cast-iron soil pipe T-branch**][**Hubless, cast-iron soil pipe test tee**] as required to match connected piping.
5. Closure Plug:

a. Material: [**Brass**][**Cast iron**] .
b. Closure Type: [**Countersunk**][**raised**] head.
c. Drilled and threaded for cover attachment screw.
d. Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access, Cover Plate: Round, [**deep, chrome-plated bronze**][**flat, chrome-plated brass or stainless steel**] cover plate with screw.
7. Wall Access, Frame and Cover: [**Round**][**Square**] , [**nickel-bronze, copper-alloy, or stainless steel**] wall-installation frame and cover.

F. Cleanouts, Plastic, Floor Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Endura; a Canplas Industries Company**]
b. [**IPS Corporation**]
c. [**NDS Inc**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. [**Zurn; Zurn Elkay**]

2. Size: Same as connected branch.
3. Body: [**ABS**][**PVC**] .
4. Closure Plug: [**ABS**][**PVC**] .
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.4 AIR-ADMITTANCE VALVES

A. Air-Admittance Valves, at Fixture :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Oatey Co.**]
b. [**ProVent Systems**]
c. [**Studor, Inc.; a brand of IPS Corporation**]

2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: [**ABS**][**PVC**] .
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

B. Air-Admittance Valves, Stack Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Oatey Co.**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Studor, Inc.; a brand of IPS Corporation**]

2. Standard: ASSE 1050 for vent stacks.
3. Housing: [**ABS**][**PVC**] .
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected stack vent or vent stack.

C. Air-Admittance Valves, Wall Box :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Oatey Co.**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Studor, Inc.; a brand of IPS Corporation**]

2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: Approximately **6 inches wide by 6 inches high by 4 inches deep (150 mm wide by 150 mm high by 100 mm deep)**.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains :

1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
2. Size: Same as connected waste piping [**with increaser fitting of size indicated**] .

B. Deep-Seal Traps :

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2 (DN 50): **4-inch- (100-mm-)** minimum water seal.
b. NPS 2-1/2 (DN 65) and Larger: **5-inch- (125-mm-)** minimum water seal.

C. Floor Drain, Trap-Seal Primer Fittings :

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with **NPS 1/2 (DN 15)** side inlet.

D. Floor Drain, Inline Trap Seal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Green Drain, Inc.**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**RectorSeal Plumbing; A CSW Industrials Company**]
f. [**Sure Seal; a RectorSeal brand**]
g. [**Zurn; Zurn Elkay**]

2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: [**Polypropylene**][**ABS**][**EPDM**][**Silicone rubber**] .
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: [**ICC-ES**][**IAPMO**] listed.
6. Size: Same as floor drain outlet or strainer throat.

E. Air-Gap Fittings :

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

F. Sleeve Flashing Device :

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend [**1 inch (25 mm)**][**2 inches (51 mm)**] above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

G. Stack Flashing Fittings :

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Vent Caps :

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

I. Frost-Resistant Vent Terminals :

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide **1-inch (25-mm)** enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

J. Expansion Joints :

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION OF BACKWATER VALVES

A. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

3.2 INSTALLATION OF CLEANOUTS

A. Install cleanouts in aboveground piping and building drain piping in accordance with the following, unless otherwise indicated:

1. Size same as drainage piping up to **NPS 4 (DN 100)**. Use **NPS 4 (DN 100)** for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of **50 ft. (15 m)** for piping **NPS 4 (DN 100)** and smaller and **100 ft. (30 m)** for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

3.3 INSTALLATION OF AIR-ADMITTANCE VALVES

A. Install fixture air-admittance valves on fixture drain piping.

B. Install stack air-admittance valves at top of stack vent and vent stack piping.

C. Install air-admittance-valve wall boxes recessed in wall.

3.4 INSTALLATION OF MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains: Assemble open drain fittings and install with top of hub [**1 inch (25 mm)**][**2 inches (51 mm)**] above floor.

B. Deep-Seal Traps: Install deep-seal traps on floor drains and other waste outlets, as indicated [**in the floor drain schedule**][**on Drawings**] .

C. Floor Drain, Trap-Seal Primer Fittings: Install floor drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

D. Floor Drain, Inline Trap Seal: Install inline trap seal device in the outlet of the floor drain in accordance with manufacturer's written instructions.

1. Verify that the floor drain is clean and free of debris.
2. Insert the trap seal into the drain outlet so that it seats fully and forms a secure, watertight fit without distortion.
3. Ensure the device is oriented correctly to maintain proper one-way flow and prevent sewer gas backflow.
4. After installation, pour water through the drain to confirm unrestricted flow and proper operation of the trap seal.
5. Protect inline trap seals from construction debris and damage until Project completion.

E. Air-Gap Fittings: Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

F. Sleeve Flashing Device: Install sleeve and sleeve seals with each riser passing through floors with waterproof membrane.

1. Ensure the pipe is clean and free of debris.

G. Stack Flashing Fittings: Install stack flashing fittings and seals with each stack passing through floors with waterproof membrane.

1. Ensure the pipe is clean and free of debris.

H. Vent Caps: Install vent caps on each vent pipe passing through roof.

1. Ensure the pipe is clean and free of debris.
2. Use setscrews to fasten the cap to the pipe, making sure it is tight and vandal-proof.
3. Confirm that there is at least a **1-inch (25-mm)** gap between the pipe and the roof substrate.

I. Frost-Resistant Vent Terminals: Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain **1-inch (25-mm)** clearance between vent pipe and roof substrate.

1. Ensure the pipe is clean and free of debris.

J. Expansion Joints: Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

K. Blocking: Install blocking reinforcement for wall-mounting-type specialties.

L. Traps, General: Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.5 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.6 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19 00

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SECTION 22 13 19 00A - HIGH-EFFICIENCY PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HEPA rigid-cell box filters.
2. HEPA V-bank cell filters.
3. HEPA filter diffusers.
4. HEPA filter fan modules.
5. ULPA filters.
6. 95 percent DOP filters.
7. HEPA/ULPA filter holding frames.
8. Side-access HEPA/ULPA filter housings.
9. Side-access HEPA/ULPA filter containment housings.
10. HEPA, ULPA, and 95 percent DOP filter gauges.

B. Related Requirements:

1. Section 233119 "HVAC Casings" for customized housings used for HEPA filters.
2. Section 234100 "Particulate Air Filtration" for particulate-air filters used in combination with HEPA filters.

1.2 DEFINITIONS

A. DOP: Dioctyl phthalate.

B. HEPA: High-efficiency particulate air.

C. PAO: Poly-alpha-olefin.

D. PSL: Polystyrene latex.

E. ULPA: Ultralow penetration air.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air filters.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
3. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for filters, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each filter, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide [**one**]<**Insert number**> complete set(s) of filters for each filter bank. If system includes prefilters, provide only prefilters.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean, dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Replace installed products damaged during construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. ASHRAE 62.1 Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."

C. Comply with NFPA 90A and NFPA 90B.

D. Comply with UL 900.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.

F. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**][**24 by 12 inches (600 by 300 mm)**][**12 by 24 inches (300 by 600 mm)**]<**Insert dimensions**>.
3. Depth: <**Insert number**> **inches (mm)** nominal.
4. Surface Area: <**Insert number**> **sq. ft. (sq. m)**.
5. Number of Filters, Wide by High: <**Insert number wide by number high**>.
6. System Airflow: <**Insert number**> **cfm (L/s)**.
7. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
8. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
9. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
10. Access: [**Front**][**Back**][**Side**].
11. Performance Level: [**99.97 percent HEPA**][**99.9997 percent ULPA**][**95 percent DOP**]<**Insert requirement**>.

2.2 HEPA RIGID-CELL BOX FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Camfil Farr Inc.**]
4. [**Flanders Corporation**]
5. [**Glasfloss Industries**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Camfil Farr Inc.**]
4. [**Flanders Corporation**]
5. [**Glasfloss Industries**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated, disposable, packaged air filters with media perpendicular to airflow and with holding frames.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

F. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.

1. Internal Separators: [**None**][**Corrugated aluminum**]<**Insert type**>.
2. Media to Filter Frame Seal Material: [**Polyurethane**]<**Insert material**>.
3. Faceguard Material: [**Aluminum**][**Stainless steel**]<**Insert material**>.
4. Faceguard Location: [**None**][**Upstream**][**and**][**downstream**].

G. Filter-Media Frames:

1. Material: [**Fire-retardant plywood**][**Aluminum**][**Fire-retardant particleboard**][**Galvanized steel**][**Non-fire-retardant particleboard**]<**Insert material**>.
2. Filter Frame to Mounting Frame Seal Material: [**Neoprene**][**Knife edge in silicone gel-filled channel**][**Knife edge in urethane gel-filled channel**]<**Insert material**>.
3. Filter Frame to Mounting Frame Seal Location: [**Upstream**][**Downstream**].
4. Style: [**Box**][**Gel track**]<**Insert style**>.

2.3 HEPA V-BANK CELL FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated, disposable, packaged air filters with media at an angle to airflow and with holding frames.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

F. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.

1. Internal Separators: [**None**][**Corrugated aluminum**]<**Insert type**>.
2. Media to Filter Frame Seal Material: [**Polyurethane**]<**Insert sealant**>.

G. Filter-Media Frames:

1. Material: [**Fire-retardant plywood**][**Aluminum**][**Fire-retardant particleboard**][**Galvanized steel**][**Non-fire-retardant particleboard**]<**Insert material**>.
2. Filter Frame to Mounting Frame Seal Material: [**Neoprene**][**Knife edge in silicone gel-filled channel**][**Knife edge in urethane gel-filled channel**]<**Insert material**>.
3. Filter Frame to Mounting Frame Seal Location: [**Upstream**][**Downstream**].
4. Style: [**Box**][**Gel track**]<**Insert style**>.

2.4 HEPA FILTER DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Envirco**]
4. [**Flanders Corporation**]
5. [**Microzone Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Envirco**]
4. [**Flanders Corporation**]
5. [**Microzone Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated, individually ducted, HEPA filter-holding ceiling modules.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

F. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with separators.

1. Media to Frame Side Bond: Urethane or polyurethane sealant.
2. Frame to Grid Bond: <**Insert type of gasket**>[**gasket**][**Knife edge for gel-filled channel**].
3. Application: [**Class 100,000 (ISO 8)**][**Class 10,000 (ISO 7)**][**Class 1,000 (ISO 6)**][**Class 100 (ISO 5)**][**Class 10 (ISO 4)**]<**Insert class**> clean room.

G. Casing:

1. Configuration: [**Ducted**][**Plenum**] inlet.
2. Module Material: [**Minimum 16-gauge (0.508-mm) extruded aluminum**]<**Insert gauge and material**> with [**mill**]<**Insert type**> finish.
3. Suspension: [**Ceiling grid**][**Independent**].

H. Accessories:

1. [**Fixed**][**Adjustable**] diffusion damper.
2. Diffusion-damper adjustment port.
3. Filter test port.

2.5 HEPA FILTER FAN MODULES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Envirco**]
4. [**Microzone Corporation**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Envirco**]
4. [**Microzone Corporation**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated, HEPA filter ceiling module with fan.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

F. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with separators.

1. Frame Material: [**Aluminum**]<**Insert material**>.
2. Media to Frame Side Bond: Urethane or polyurethane sealant.
3. Frame to Grid Bond: <**Insert type of gasket**>[**gasket**][**Knife edge for gel-filled channel**].
4. Application: [**Class 100,000 (ISO 8)**][**Class 10,000 (ISO 7)**][**Class 1,000 (ISO 6)**][**Class 100 (ISO 5)**][**Class 10 (ISO 4)**]<**Insert class**> clean room.
5. Faceguard: [**Stainless steel**]<**Insert material**>.

G. Casing:

1. Configuration: [**Ducted inlet**][**Plenum inlet**][**Plenum inlet with MERV 8 prefilter**].
2. Module Material: [**Minimum 16-gauge (0.508-mm) extruded aluminum**]<**Insert gauge and material**> with [**mill**]<**Insert type**> finish.
3. Suspension: [**Ceiling grid**][**Independent**].

H. Accessories: Filter test port.

I. Motor:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Type: [**Permanent-split capacitor with SCR for speed adjustment**][**Electronically commutated motor**].
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: <**Insert type**>.
5. Enclosure Materials: <**Insert type**>.
6. Motor Bearings: <**Insert special requirements**>.
7. Unusual Service Conditions:

    a. Ambient Temperature: <**Insert number**>**deg F (deg C)**.
    b. Altitude: <**Insert number**> **feet (m)** above sea level.
    c. High humidity.
    d. <**Insert conditions**>.

8. Efficiency: Premium efficient.
9. NEMA Design: <**Insert designation**>.
10. Service Factor: <**Insert value**>.
11. Motor Speed: [**Single speed**][**Multispeed**][**with variable-speed control**].
12. Electrical Characteristics:

a. Horsepower: <**Insert number**> hp.
b. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
c. Phase: [**Single**][**Three**].
d. Hertz: 60 Hz.
e. Full-Load Amperes: <**Insert number**> A.
f. Minimum Circuit Ampacity: <**Insert number**> A.
g. Maximum Overcurrent Protection: <**Insert number**> A.

2.6 ULPA FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated ULPA filters with holding casing.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC007.3.
4. Comply with IEST-RP-CC034.4.

F. Media: Fibrous material, constructed of continuous sheets with closely spaced pleats that are maintained under rated-airflow conditions.

1. Internal Separators: [**None**][**Corrugated aluminum**]<**Insert type**>.
2. Media to Filter Frame Seal Material: [**Polyurethane**]<**Insert material**>.
3. Faceguard Material: [**Aluminum**][**Stainless steel**]<**Insert material**>.
4. Faceguard Location: [**None**][**upstream**][**and**][**downstream**].

G. Filter-Media Frames:

1. Material: [**Fire-retardant plywood**][**Aluminum**][**Fire-retardant particleboard**][**Galvanized steel**][**Non-fire-retardant particleboard**]<**Insert material**>.
2. Filter Frame to Mounting Frame Seal Material: [**Neoprene**][**Silicone Gel**][**Urethane Gel**]<**Insert material**>.

3. Filter Frame to Mounting Frame Seal Location: [**Upstream**][**Downstream**].
4. Style: [**Box**][**Gel track**]<**Insert style**>.

2.7 95 PERCENT DOP FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain filters from single source from single manufacturer.

D. Description: Factory-fabricated, 95 percent DOP filters with holding casing.

E. Media: Fibrous material, constructed of continuous sheets with closely spaced pleats that are maintained under rated-airflow conditions.

1. Internal Separators: [**None**][**Corrugated aluminum**]<**Insert type**>.
2. Media to Filter Frame Seal Material: [**Polyurethane**]<**Insert material**>.
3. Faceguard Material: [**Aluminum**][**Stainless steel**]<**Insert material**>.
4. Faceguard Location: [**None**][**Upstream**][**Downstream**].

F. Filter-Media Frames:

1. Material: [**Fire-retardant plywood**][**Aluminum**][**Fire-retardant particleboard**][**Galvanized steel**][**Non-fire-retardant particleboard**]<**Insert material**>.
2. Filter Frame to Mounting Frame Seal Material: [**Neoprene**][**Knife edge in silicone gel-filled channel**][**Knife edge in urethane gel-filled channel**].
3. Filter Frame to Mounting Frame Seal Location: [**Upstream**][**Downstream**].
4. Style: [**Box**][**Gel track**]<**Insert style**>.

2.8 HEPA/ULPA FILTER HOLDING FRAMES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]

4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Framing members with access for upstream (front) or downstream (back) filter servicing, cut to size and prepunched for assembly into modules, specifically designed for HEPA/ULPA/95 percent DOP filter banks.

E. Material: Minimum **14-gauge (1.9-mm)** [**stainless-**][**or**][**galvanized-**]steel framing members. Factory-prepunched holes and dimples for ease of filter alignment and assembly.

F. Prefilters: Incorporate a separate holding frame for prefilter, removable from front or back.

G. Gasketed Sealing: Factory-installed, positive-sealing device for each filter to ensure seal between gasketed filter elements to prevent bypass of unfiltered air. Filter latching mechanism to seat each filter firmly against holding frame surface.

H. Knife-Edge Sealing: Knife-edge to mate with [**HEPA**][**and**][**ULPA**] filter elements to prevent bypass of unfiltered air. Factory-installed, positive-locking mechanism for each filter to seat the knife edge into the gel during installation and to remove the filter from the knife edge during filter replacement.

2.9 SIDE-ACCESS HEPA/ULPA FILTER HOUSINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-assembled, side-access filter housings, specifically designed for HEPA/ULPA/95 percent DOP filter banks, with flanges to connect to duct or casing system.

E. Factory Testing: Factory pressure test housing and sealed joints at [**6.0-inch wg (1500 Pa)**]<**Insert value**>. Document and submit to confirm maximum <**Insert percentage**> leakage.

F. Materials: [**Galvanized steel**]<**Insert material**>[**double-wall casing with 1-inch (25-mm) insulation**][**double-wall casing with 2-inch (50-mm) insulation**].

1. Pressure taps and fittings.
2. DOP test ports.
3. Mounted magnehelic gauges.

G. Prefilters: Integral tracks to accommodate [**2-inch- (50-mm-)**][**4-inch- (100-mm-)**]<**Insert dimension**> thick, disposable [**or washable**]filters.

H. Access Doors: [**Hinged, with continuous**][**Continuous**] gaskets on perimeter and positive-locking devices. Arranged for filter access from [**one-side**][**both-sides**] access door.

I. Gasketed Sealing: Factory-installed, positive-sealing device for each filter to ensure seal between gasketed filter elements to prevent bypass of unfiltered air. Filter latching mechanism to seat each filter firmly against side-access housing channel surface.

J. Knife-Edge Sealing: Knife-edge to mate with [**HEPA**][**and**][**ULPA**] filter elements to prevent bypass of unfiltered air. Factory-installed, positive-locking mechanism for each filter to seat the knife edge into the gel during installation and to remove the filter from the knife edge during filter replacement.

2.10 SIDE-ACCESS HEPA/ULPA FILTER CONTAINMENT HOUSINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-assembled, side-access housings, with bag in/bag out feature to protect maintenance personnel from coming into direct contact with the interior of the housing and the contaminated filter media during required filter change out, with flanges to connect to duct or casing system.

E. Standards: Test according to ASME AG-1.

F. Casing:

1. Material: Constructed of minimum 16-gauge- (1.5-mm-) thick, [**galvanized steel**][**stainless steel**][**, double-wall casing with 2-inch (50-mm) fiberglass insulation,**] to hold filters. Side servicing through gasketed access doors on one side. Equip housings to be capable of connection to other housings. Equip housings with metal slide channel tracks and locking mechanisms to hold filters, and the following:

   a. Pressure gauge tap and fitting.
   b. DOP test ports.
   c. Lifting lugs.

2. Casing Pressure: Casing constructed for up to [**positive/negative 6.0-inch wg (1500 Pa)**][**positive/negative 10-inch wg (2500 Pa)**]<**Insert casing pressure requirement**>.

G. Isolation Dampers:

1. Material: Stainless-steel body, blade, and flanges.
2. Round Damper Blade: <**Insert diameter**> damper, replaceable, solid silicone gasket sandwiched between stainless-steel plates, providing silicone gasket blade to knife edge seal.

   a. Bubble-tight seal at minimum 10-inch wg (2490-Pa) differential pressure to comply with ASME N509.

H. Prefilters: Integral tracks to accommodate [2-inch- (50-mm-)][4-inch- (100-mm-)] thick, disposable filters.

I. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Provide ribbed bagging rim behind access door and PVC bags for bag-in, bag-out arrangement. Arrange so filter cartridges can be loaded from an access door for each tier and section of the following:

1. Combination prefilter and HEPA filter.
2. HEPA filter.
3. Upstream and downstream test section.

J. Gasketed Sealing: Factory-installed, positive-sealing device for each filter to ensure seal between gasketed filter elements to prevent bypass of unfiltered air. Filter locking mechanism to seat each filter firmly against side-access housing channel surface.

K. Knife-Edge Sealing: Knife-edge to mate with [**HEPA**][**and**][**ULPA**] filter elements to prevent bypass of unfiltered air. Factory-installed, positive-locking mechanism for each filter to seat the knife edge into the gel during installation and to remove the filter from the knife edge during filter replacement.

L. Accessories:

1. Filter change-out trays.
2. Document-storage pocket.
3. Filter removal rod.

2.11 HEPA, ULPA, AND 95 PERCENT DOP FILTER GAUGES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Ashcroft Inc**]
2. [**Dwyer Instruments, Inc**]
3. [**Orange Research**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ashcroft Inc**]
2. [**Dwyer Instruments, Inc**]
3. [**Orange Research**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Diameter: [**4-1/2 inches (115 mm)**][**2-1/2 inches (75 mm)**]<**Insert dimension**>.
2. Material: [**Stainless-steel**]<**Insert material**> case and [**die-cast aluminum**][**stainless-steel**]<**Insert material**> body with [**wetted material matching body material**]<**Insert wetted material**>.
3. Accuracy: [**Plus/minus 2 percent of full scale**]<**Insert accuracy**>.
4. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: **0- to 3.0-inch wg (0 to 750 Pa)**.
5. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: **0- to 4.0-inch wg (0 to 1000 Pa)**.

E. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FILTERS

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters that were used during construction and testing with new, clean filters.

D. Coordinate filter installations with duct and air-handling unit installations.

3.3 INSTALLATION OF HEPA, ULPA, AND 95 PERCENT DOP FILTER GAUGES

A. Install filter gauge for each filter bank.

B. Install filter-gauge, static-pressure tips upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between pressure sensors and [**DDC system**]<**Insert system description**>.

C. Connect control wiring between controlled devices.

D. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. HEPA and ULPA Filters: Pressurize housing to a minimum of [**6.0-inch wg (1500 Pa)**]<**Insert value**>, and test housing joints, door seals, and sealing edges of filter for air leaks according to pressure-decay method in ASME AG-1.

E. Air filter will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

3.7 PROTECTION

A. Protect installed products and accessories from damage during construction.

END OF SECTION 22 13 19 00A

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Task	Specification	Specification Description
22 13 19 00	22 13 00 00	Facility Gray-Water Storage Tanks

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SECTION 22 13 19 13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks.
3. Trench drains.
4. Concrete trench drain-forming system.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sanitary drains are to bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Floor Drain - Cast Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Commercial Enameling Company**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**Prier Products, Inc.**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**Wade; a subsidiary of McWane Inc.**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Whitehall Manufacturing; a division of Morris Group International**]
j. [**Zurn Industries, LLC**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Commercial Enameling Company**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**Prier Products, Inc.**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**Wade; a subsidiary of McWane Inc.**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Whitehall Manufacturing; a division of Morris Group International**]
j. [**Zurn Industries, LLC**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron floor drains from single manufacturer.
4. Standard: ASME A112.6.3[**with backwater valve**].
5. Pattern: [**Area**][**Floor**][**Funnel floor**][**Sanitary**]<**Insert pattern**> drain.
6. Body Material: [**Gray iron**]<**Insert material**>.
7. Seepage Flange: [**Not required**][**Required**].
8. Anchor Flange: [**Not required**][**Required**].
9. Clamping Device: [**Not required**][**Required**].
10. Outlet: [**Bottom**][**Side**]<**Insert type**>.
11. Backwater Valve: [**Drain-outlet type**][**Integral, ASME A112.14.1, swing-check type**][**Not required**].
12. Coating on Interior and Exposed Exterior Surfaces: [**Acid-resistant enamel**][**Not required**]<**Insert material**>.
13. Sediment Bucket: [**Not required**]<**Insert description**>.
14. Top or Strainer Material: [**Bronze**][**Gray iron**][**Nickel bronze**][**Stainless steel**]<**Insert material**>.
15. Top of Body and Strainer Finish: [**Nickel bronze**][**Polished bronze**][**Rough bronze**][**Stainless steel**]<**Insert finish**>.
16. Top Shape: [**Round**][**Square**]<**Insert shape**>.
17. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
18. Top Loading Classification: [**Extra Heavy Duty**][**Heavy Duty**][**Light Duty**][**Medium Duty**].
19. Funnel: [**Not required**][**Required**]<**Insert description and dimensions**>.
20. Inlet Fitting: [**Not required**][**Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection**].
21. Trap Material: [**Bronze**][**Cast iron**][**Copper**][**Not required**]<**Insert material**>.
22. Trap Pattern: [**Deep-seal P-trap**][**Standard P-trap**][**Not required**]<**Insert pattern**>.
23. Trap Features: [**Cleanout**][**Trap-seal primer valve drain connection**][**Cleanout and trap-seal primer valve drain connection**][**Not required**]<**Insert type**>.

B. Floor Drain - Stainless Steel, ASME A112.3.1 :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Zurn Industries, LLC**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Zurn Industries, LLC**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain stainless steel floor drains, ASME A112.3.1, from single manufacturer.
4. Standard: ASME A112.3.1.
5. Outlet: [**Bottom**][**Side**]<**Insert type**>.
6. Top or Strainer Material: [**Stainless steel**]<**Insert material**>.
7. Top Shape: [**Round**][**Square**]<**Insert shape**>.
8. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
9. Seepage Flange: [**Not required**][**Required**].
10. Anchor Flange: [**Not required**][**Required**].
11. Clamping Device: [**Not required**][**Required**].
12. Trap-Primer Connection: [**Not required**][**Required**].
13. Trap Material: [**Cast iron**][**Stainless steel**][**Not required**]<**Insert material**>.
14. Trap Pattern: [**Deep-seal P-trap**][**Standard P-trap**][**Not required**]<**Insert pattern**>.

C. Floor Drain - Stainless Steel, ASME A112.6.3 :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACO, Inc.**]
    b. [**BLÜCHER; A Watts Water Technologies Company**]
    c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    d. [**Josam Company**]
    e. [**Kusel Equipment Co**]
    f. [**Scherping Systems, Inc.**]
    g. [**Sioux Chief Manufacturing Company, Inc.**]
    h. [**Wade; a subsidiary of McWane Inc.**]
    i. [**WATTS; A Watts Water Technologies Company**]
    j. [**Zurn Industries, LLC**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACO, Inc.**]
    b. [**BLÜCHER; A Watts Water Technologies Company**]
    c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]

d. [**Josam Company**]
e. [**Kusel Equipment Co**]
f. [**Scherping Systems, Inc.**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**Wade; a subsidiary of McWane Inc.**]
i. [**WATTS; A Watts Water Technologies Company**]
j. [**Zurn Industries, LLC**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain stainless steel floor drains, ASME A112.6.3, from single manufacturer.
4. Standard: ASTM A112.6.3.
5. Outlet: [**Bottom**][**Side**]<**Insert type**>.
6. Top or Strainer Material: [**Stainless steel**]<**Insert material**>.
7. Top Shape: [**Round**][**Square**]<**Insert shape**>.
8. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
9. Seepage Flange: [**Not required**][**Required**].
10. Anchor Flange: [**Not required**][**Required**].
11. Clamping Device: [**Not required**][**Required**].
12. Trap-Primer Connection: [**Not required**][**Required**].
13. Trap Material: [**Cast iron**][**Stainless steel**][**Not required**]<**Insert material**>.
14. Trap Pattern: [**Deep-seal P-trap**][**Standard P-trap**][**Not required**]<**Insert pattern**>.

D. Floor Drain - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Endura; a brand of IPEX**]
   b. [**IPS Corporation**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Josam Company**]
   e. [**Oatey Co.**]
   f. [**Plastic Oddities**]
   g. [**Schluter Systems L.P.**]
   h. [**Sioux Chief Manufacturing Company, Inc.**]
   i. [**Zurn Industries, LLC**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Endura; a brand of IPEX**]
   b. [**IPS Corporation**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Josam Company**]
   e. [**Oatey Co.**]
   f. [**Plastic Oddities**]
   g. [**Schluter Systems L.P.**]
   h. [**Sioux Chief Manufacturing Company, Inc.**]
   i. [**Zurn Industries, LLC**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain plastic floor drains from single manufacturer.
4. Standard: ASME A112.6.3.
5. Material: [**ABS**][**or**][**PVC**]<**Insert material**>.
6. Seepage Flange: [**Not required**][**Required**].
7. Clamping Device: [**Not required**][**Required**].
8. Outlet: [**Bottom**][**Side**]<**Insert type**>.
9. Sediment Bucket: [**Not required**]<**Insert description**>.
10. Top or Strainer Material: [**Bronze**][**Plastic**][**Stainless steel**]<**Insert other**>.
11. Top of Body and Strainer Finish: [**Nickel bronze**][**Polished bronze**][**Rough bronze**][**Stainless steel**]<**Insert other**>.
12. Top Shape: [**Round**][**Square**]<**Insert shape**>.
13. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate if required**>.
14. Trap Material: [**Cast iron**][**Plastic drainage piping**][**Not required**]<**Insert material**>.
15. Trap Pattern: [**Standard P-trap**][**Not required**]<**Insert pattern**>.

2.3 FLOOR SINKS

A. Floor Sink - Cast Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Commercial Enameling Company**]
    b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    c. [**Wade; a subsidiary of McWane Inc.**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Commercial Enameling Company**]
    b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    c. [**Wade; a subsidiary of McWane Inc.**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron floor sinks from single manufacturer.
4. Standard: ASME A112.6.7.
5. Pattern: [**Floor**][**Funnel floor**]<**Insert pattern**> drain.
6. Body Material: Cast iron.
7. Anchor Flange: [**Not required**][**Required**][**, with seepage holes**].
8. Clamping Device: [**Not required**][**Required**].
9. Outlet: Bottom, [**no-hub**]<**Insert type**> connection.
10. Coating on Interior Surfaces: [**Not required**][**Acid-resistant enamel**]<**Insert coating**>.
11. Sediment Bucket: [**Not required**]<**Insert description**>.
12. Internal Strainer: [**Not required**][**Dome**][**Flat**].
13. Internal Strainer Material: [**Aluminum**]<**Insert material**>.
14. Top Grate Material: [**Cast iron**]<**Insert material**>[**, loose**][**, hinged**].

15. Top of Body and Grate Finish: [**Nickel bronze**][**Acid-resistant enamel**]<**Insert finish**>.
16. Top Shape: [**Round**][**Square**]<**Insert shape**>.
17. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
18. Top Loading Classification: [**No traffic**]<**Insert traffic loading**>.
19. Funnel: [**Not required**][**Required**]. <**Insert material, shape and dimensions**>.
20. <**Insert additional options here**>.

B. Floor Sink - Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Wade; a subsidiary of McWane Inc.**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Wade; a subsidiary of McWane Inc.**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain stainless steel floor sinks from single manufacturer.
4. Standard: ASME A112.6.7.
5. Pattern: [**Floor**][**Funnel floor**]<**Insert pattern**> drain.
6. Body Material: Stainless steel.
7. Anchor Flange: [**Not required**][**Required**][**, with seepage holes**].
8. Clamping Device: [**Not required**][**Required**].
9. Outlet: Bottom, [**no-hub**]<**Insert type**> connection.
10. Sediment Bucket: [**Not required**]<**Insert description**>.
11. Internal Strainer: [**Not required**][**Dome**][**Flat**].
12. Internal Strainer Material: [**Stainless steel**]<**Insert material**>.
13. Top Grate Material: [**Stainless steel**]<**Insert material**>[**, loose**][**, hinged**].
14. Top of Body and Grate Finish: [**Satin nickel**][**Stainless steel**]<**Insert finish**>.
15. Top Shape: [**Round**][**Square**]<**Insert shape**>.
16. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
17. Top Loading Classification: [**No traffic**]<**Insert traffic loading**>.
18. Funnel: [**Not required**][**Required**]. <**Insert material, shape and dimensions**>.
19. <**Insert additional options here**>.

C. Floor Sink - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Endura; a brand of IPEX**]
b. [**IPS Corporation**]
c. [**Oatey Co.**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Endura; a brand of IPEX**]
b. [**IPS Corporation**]
c. [**Oatey Co.**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain plastic floor sinks from single manufacturer.
4. Standard: ASME A112.6.7.
5. Pattern: [**Floor**][**Funnel floor**]<**Insert pattern**> drain.
6. Body Material: PVC.
7. Outlet: Bottom, PVC primer and solvent cement connection.
8. Sediment Bucket: [**Not required**]<**Insert description**>.
9. Internal Strainer: [**Not required**][**Dome**][**Flat**].
10. Internal Strainer Material: [**PVC**]<**Insert material**>.
11. Top Grate Material: [**PVC**]<**Insert material**>.
12. Top Shape: [**Round**][**Square**]<**Insert shape**>.
13. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
14. Top Loading Classification: [**No traffic**]<**Insert traffic loading**>.
15. Funnel: [**Not required**][**Required**]. <**Insert material, shape and dimensions**>.
16. <**Insert additional options here**>.

2.4 TRENCH DRAINS

A. Trench Drain, Individual - Cast Iron or Ductile Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Wade; a subsidiary of McWane Inc.**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]

b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Wade; a subsidiary of McWane Inc.**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain trench drains from single manufacturer.
4. Standard: ASME A112.6.3 for trench drains.
5. Material: Cast iron or ductile iron body.
6. Flange: [**Anchor**][**Seepage**][**Not required**].
7. Clamping Device: [**Not required**][**Required**].
8. Outlet: [**Bottom**][**End**][**Side**]<**Insert location**>.
9. Grate Material: [**Ductile iron**][**Ductile iron or gray iron**][**Gray iron**][**Stainless steel**]<**Insert material**>.
10. Grate Finish: [**Painted**][**Not required**]<**Insert finish**>.
11. Dimensions of Frame and Grate: <**Insert dimensions and describe body, sump, and grate if required**>.
12. Top Loading Classification: [**Extra Heavy Duty**][**Heavy Duty**][**Light Duty**][**Medium Duty**].
13. Trap Material: [**Cast iron**][**Stainless steel**][**Not required**]<**Insert material**>.
14. Trap Pattern: [**Standard P-trap**][**Not required**]<**Insert pattern**>.

B. Trench Drain, Individual - Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**WATTS; A Watts Water Technologies Company**]
   b. [**Whitehall Manufacturing; a division of Morris Group International**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**WATTS; A Watts Water Technologies Company**]
   b. [**Whitehall Manufacturing; a division of Morris Group International**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain stainless steel trench drain from single manufacturer.
4. Description: Stainless steel trench consisting of sloped trench body, grates, and appurtenances; designed so grates fit into trench body recesses without rocking or rattling.
5. Standard: ASME A112.6.3.
6. Dimensions: <**Insert dimensions**> wide by <**Insert dimensions long**>.
7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channels.

   a. Material: Stainless steel.
   b. Locking Mechanism: [**Manufacturer's standard device for securing grates to body channel**][**Not required**].

8. Covers: Solid stainless steel of width and thickness that fit recesses in channel, and of length indicated.

9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.

C. Trench Drain, Modular Channel System - Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACO, Inc.**]
   b. [**BLÜCHER; A Watts Water Technologies Company**]
   c. [**Eric'sons**]
   d. [**MultiDrain Systems, Inc.**]
   e. [**Vodaland**]
   f. [**Whitehall Manufacturing; a division of Morris Group International**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACO, Inc.**]
   b. [**BLÜCHER; A Watts Water Technologies Company**]
   c. [**Eric'sons**]
   d. [**MultiDrain Systems, Inc.**]
   e. [**Vodaland**]
   f. [**Whitehall Manufacturing; a division of Morris Group International**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain modular stainless steel channel systems, from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of stainless steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking joint, stainless steel with level invert.

   a. Dimensions: [**6 inches (152 mm)**][**12 inches (305 mm)**] wide. Include number of units required to form total lengths indicated.

7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channels.

   a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
   b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile or gray iron**][**stainless steel**]<**Insert material**>, of width and thickness that fit recesses in channels, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

D. Trench Drain, Modular Channel System - Polymer Concrete, Narrow, Sloped Invert :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**MultiDrain Systems, Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**MultiDrain Systems, Inc.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain narrow, sloped-invert, polymer-concrete channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
b. Include extension sections necessary for required depth.
c. Dimensions: [**4-inch (102-mm)**]<**Insert dimension**> inside width. Include number of units required to form total lengths indicated.
d. Frame: [**Gray-iron, cast iron, or galvanized steel for grates**][**Not required**]<**Insert material**>.

7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

E. Trench Drain, Modular Channel System - Polymer Concrete, Narrow, Level Invert :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABT, Inc.**]
    b. [**ACO, Inc.**]
    c. [**Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    e. [**Josam Company**]
    f. [**MultiDrain Systems, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABT, Inc.**]
    b. [**ACO, Inc.**]
    c. [**Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    e. [**Josam Company**]
    f. [**MultiDrain Systems, Inc.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain narrow, level-insert, polymer-concrete channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

    a. Include rounded bottom, with level invert and with **NPS 4 (DN 100)** outlets in number and locations indicated.
    b. Dimensions: [**5-inch (127-mm)**]<**Insert dimension**> inside width and [**9-3/4 inches (248 mm)**]<**Insert dimension**> inside depth. Include number of units required to form total lengths indicated.
    c. Frame: [**Gray-iron or galvanized steel for grates**][**Not required**]<**Insert material**>.

7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

    a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Cast iron or gray iron**][**Stainless steel**]<**Insert material**>.
    b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile, cast, or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

F. Trench Drain, Modular Channel System - Polymer Concrete, Wide, Level Invert :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**Josam Company**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**Josam Company**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wide, level-insert, polymer-concrete channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.

a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
b. Dimensions: [**8-inch (203-mm)**]<**Insert dimension**> inside width and [**13-3/4 inches (350 mm)**]<**Insert dimension**> inside depth. Include number of units required to form total lengths indicated.
c. Frame: [**Galvanized steel, gray iron, or cast iron for grates**][**Not required**]<**Insert material**>.

7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

G. Trench Drain, Modular Channel System - FRP :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACO, Inc.**]
    b. [**Aquaduct, Inc.**]
    c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACO, Inc.**]
    b. [**Aquaduct, Inc.**]
    c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain FRP channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.

    a. Dimensions: [**4 inches (102 mm)**][**4 or 6 inches (102 or 152 mm)**][**6 inches (152 mm)**][**6 or 8 inches (152 or 203 mm)**][**8 inches (203 mm)**] wide. Include number of units required to form total lengths indicated.
    b. Frame: [**Galvanized steel**][**Stainless steel**][**Manufacturer's standard metal**]<**Insert material**> for grates.

7. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

    a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
    b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

H. Trench Drain, Modular Channel System - HDPE or PE :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Sioux Chief Manufacturing Company, Inc.**]
    c. [**Tuf-Tite Corporation**]
    d. [**Zurn Industries, LLC**]

e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Sioux Chief Manufacturing Company, Inc.**]
   c. [**Tuf-Tite Corporation**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain HDPE or PE channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking-joint, HDPE or PE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

   a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.

7. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

   a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
   b. Color: <**Insert color or delete subparagraph**>.

8. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

I. Trench Drain, Modular Channel System - PP :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Infinity Plastics, Inc.**]
   b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Infinity Plastics, Inc.**]
   b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain PP channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking-joint, PP modular units, with end caps. Include flat, rounded, or

inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.

7. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Color: <**Insert color or delete subparagraph**>.

8. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

J. Trench Drain, Modular Channel System - PVC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MultiDrain Systems, Inc.**]
b. [**NDS Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MultiDrain Systems, Inc.**]
b. [**NDS Inc**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain PVC channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking-joint, PVC modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.

7. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Color: <**Insert color or delete subparagraph**>.

8. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.5 CONCRETE TRENCH DRAIN-FORMING SYSTEM

A. Concrete Trench Drain-Forming System: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABT, Inc.**]
    b. [**ACO, Inc.**]
    c. [**Eric'sons**]
    d. [**MultiDrain Systems, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABT, Inc.**]
    b. [**ACO, Inc.**]
    c. [**Eric'sons**]
    d. [**MultiDrain Systems, Inc.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain concrete trench drain-forming system from single manufacturer.
4. Description: Radius trench-drain-forming system, including a removable form that is customizable for width, depth, length, shape, slope, frame material, and grate material.
5. Form Bottom: [**Smooth radius**][**Vee**][**Flat**]<**Insert option**>.
6. Form Use: [**Single use**][**or**][**reusable**].
7. Form Covers: Plywood or metal to keep concrete out of trench form during installation.
8. Width: [**8-inch (203-mm)**][**10-inch (254-mm)**][**12-inch (305-mm)**][**18-inch (457-mm)**][**24-inch (610-mm)**]<**Insert width**> inside dimension.
9. Depth: [**See Drawings**]<**Insert dimension**>.
10. Length: [**See Drawings**]<**Insert dimension**>.
11. Bottom Shape: [**Smooth radius**][**Vee**]<**Insert shape**>.
12. Slope: [**Level - no slope**][**0.5 percent**][**0.6 percent**][**1.0 percent**]<**Insert slope**>.
13. Frame/Grate Seat:

    a. Load Bearing, <**Insert loading requirement**>.
    b. Material: [**Powder-coated steel**][**Galvanized steel**][**Iron**][**Aluminum**][**Plastic**][**FRP**][**Stainless steel**]<**Insert material**>.

14. Concrete Anchors: [**18 inches (457 mm) o.c.**]<**Insert spacing**>.
15. Grate:

    a. Manufacturer's Load Bearing Designation: "[**Heavy**][**Medium**] Duty".
    b. Material: [**Ductile iron**][**FRP**][**Galvanized steel**][**Cast iron**][**Stainless steel**]<**Insert material**>.
    c. Grate Type: [**ADA**][**Heel-proof**][**slotted**][**perforated**][**bar**]<**Insert grate type**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF SANITARY DRAINS

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than **1/4-inch (6.35-mm)** total depression.
    b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than **1-inch (25-mm)** total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub [**1 inch (25 mm)**][**2 inches (51 mm)**]<**Insert dimension**> above floor.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19 13

Task	Specification	Specification Description
22 13 19 13	22 13 19 00	Sanitary Waste Piping Specialties
22 13 19 13	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 13	22 13 19 00a	High-Efficiency Particulate Air Filtration
22 13 19 26	22 13 19 00	Sanitary Waste Piping Specialties
22 13 19 26	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 26	22 13 19 00a	High-Efficiency Particulate Air Filtration
22 13 19 33	22 05 23 00	General-Duty Valves for Plumbing Piping
22 13 19 33	22 13 19 00	Sanitary Waste Piping Specialties
22 13 19 33	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 33	22 05 23 00a	General-Duty Valves for HVAC Piping
22 13 19 33	22 13 19 00a	High-Efficiency Particulate Air Filtration
22 13 19 36	22 13 19 00	Sanitary Waste Piping Specialties
22 13 19 36	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 36	22 13 19 00a	High-Efficiency Particulate Air Filtration

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SECTION 22 13 23 00 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interceptors, grease.
2. Grease-removal devices.
3. Interceptors, oil.
4. Interceptors, sand.
5. Interceptors, sand and oil.
6. Interceptors, solids.
7. Precast-concrete manhole risers.
8. Manhole risers, frames, and covers.
9. Sampling ports.

1.2 DEFINITIONS

A. FOGs: Fats, oils, greases.

B. FRP: Fiberglass-reinforced plastic.

C. PP: Polypropylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of sanitary waste interceptor.

1. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
2. Include diagrams of power wiring.

B. Shop Drawings: For each type and size of precast-concrete sanitary waste interceptor.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Piping connections. Include size, location, and elevation of each.
2. Interface with underground structures and utility services.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

1.6 FIELD CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 INTERCEPTORS, GREASE

A. Interceptors, Grease - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Concrete Products Co.**]
    b. [**Copeland Precast, Inc.**]
    c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
    d. [**Wieser Concrete**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advance Concrete Products Co.**]
    b. [**Copeland Precast, Inc.**]
    c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
    d. [**Wieser Concrete**]
    e. <**Insert manufacturer's name**>

3. Standard:

    a. ASTM C913.
    b. [**Specific requirements of the Authority Having Jurisdiction**].

4. Description: Factory-fabricated grease interceptor for intercepting and retaining FOG from food[**-preparation**][**or**][**-processing**] wastewater.
5. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping

or openings to retain grease and to permit wastewater flow.

6. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
7. Structural Design Loads:

    a. Light-Traffic Load: Comply with ASTM C890, A-8.
    b. Medium-Traffic Load: Comply with ASTM C890, A-12.
    c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
    d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into interceptor walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
10. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover.

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**][**GREASE INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

12. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Number of Compartments: [**One**][**Two**]<**Insert number**>.
    c. Flow Rate: <**Insert gpm (L/s)**>.
    d. Retention Capacity: <**Insert lb (kg)**>.
    e. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet: Integral.
    g. Cleanout: Integral[**or field installed on outlet**].
    h. Vent Pipe Size: <**Insert NPS (DN)**>.
    i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    j. Flow-Control Fitting: Required.
    k. Operation: [**Manual cleaning**][**Semiautomatic, manual drawoff**]<**Insert operation**>.

B. Interceptors, Grease - Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]

c. [**MIFAB, Inc**]
d. [**ParkUSA; a Northwest Pipe Company**]
e. [**Rockford Separators**]
f. [**Wade; a subsidiary of McWane Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**ParkUSA; a Northwest Pipe Company**]
e. [**Rockford Separators**]
f. [**Wade; a subsidiary of McWane Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Standard:

a. PDI G101.
b. [**ASME A112.14.3**].

4. PDI Seal: Required.
5. Description: Factory-fabricated grease interceptor for intercepting and retaining FOG from food[**-preparation**][**or**][**-processing**] wastewater.
6. Body Material: Steel.
7. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
8. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
9. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
10. Body Extension: <**Insert inches (mm)**> height.
11. Capacities and Characteristics:

a. Length by Width by Depth: <**Insert inches (mm)**>.
b. Number of Compartments: [**One**][**Two**]<**Insert number**>.
c. Flow Rate: <**Insert gpm (L/s)**>.
d. Retention Capacity: <**Insert lb (kg)**>.
e. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

f. Trapped Outlet: Integral.
g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.
k. Operation: [**Manual cleaning**][**Semiautomatic, manual drawoff**]<**Insert operation**>.

C. Interceptors, Grease - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ashland PolyTrap**]
    b. [**Bio-Microbics, Inc.**]
    c. [**Canplas Industries Ltd.**]
    d. [**MIFAB, Inc**]
    e. [**Rockford Separators**]
    f. [**Schier Products Company**]
    g. [**Town & Country Plastics, Inc**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ashland PolyTrap**]
    b. [**Bio-Microbics, Inc.**]
    c. [**Canplas Industries Ltd.**]
    d. [**MIFAB, Inc**]
    e. [**Rockford Separators**]
    f. [**Schier Products Company**]
    g. [**Town & Country Plastics, Inc**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

3. Standard:

    a. PDI G101.
    b. [**ASME A112.14.3**].

4. PDI Seal: Required.
5. Description: Factory-fabricated grease interceptor for intercepting and retaining FOG from food[**-preparation**][**or**][**-processing**] wastewater.
6. Body Material: Plastic.
7. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
8. Body Extension: <**Insert inches (mm)**> height.
9. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Number of Compartments: [**One**][**Two**]<**Insert number**>.
    c. Flow Rate: <**Insert gpm (L/s)**>.
    d. Retention Capacity: <**Insert lb (kg)**>.
    e. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet: Integral.
    g. Cleanout: Integral[**or field installed on outlet**].
    h. Vent Pipe Size: <**Insert NPS (DN)**>.
    i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.

j. Flow-Control Fitting: Required.
k. Operation: [**Manual cleaning**][**Semiautomatic, manual drawoff**]<**Insert operation**>.

2.2 GREASE-REMOVAL DEVICES

A. Grease-Removal Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**G K & L, Inc**]
   b. [**Grease Guardian**]
   c. [**Highland Tank & Manufacturing Company, Inc.**]
   d. [**International Grease Recovery Device**]
   e. [**Josam Company**]
   f. [**MIFAB, Inc**]
   g. [**Thermaco, Inc**]
   h. [**Wade; a subsidiary of McWane Inc.**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**G K & L, Inc**]
   b. [**Grease Guardian**]
   c. [**Highland Tank & Manufacturing Company, Inc.**]
   d. [**International Grease Recovery Device**]
   e. [**Josam Company**]
   f. [**MIFAB, Inc**]
   g. [**Thermaco, Inc**]
   h. [**Wade; a subsidiary of McWane Inc.**]
   i. <**Insert manufacturer's name**>

3. Standard:

   a. PDI G101.
   b. [**ASME A112.14.3**].
   c. [**ASME A112.14.4**].

4. PDI Seal: Required.
5. Description: Factory-fabricated grease-removal device for automatic intercepting and removal of FOG from food[**-preparation**][**or**][**-processing**]<**Insert application**> wastewater.
6. Body Material: [**Stainless steel**][**Steel**]<**Insert material**>.
7. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
8. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacture's acid-resistant coating.
9. Interior Separation Device: [**Baffles**][**Screens**]<**Insert device**>.
10. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
11. Capacities and Characteristics:

    a. Heater: Required.
    b. Length by Width by Depth: <**Insert inches (mm)**>.

c. Flow Rate: <**Insert gpm (L/s)**>.
d. Basket Material: [**Stainless steel**]<**Insert material**>.
e. Inlet and Outlet Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

f. Cleanout: Integral[**or field installed on outlet**].
g. Vent Pipe Size: <**Insert NPS (DN)**>.
h. Mounting: [**Above floor**]<**Insert mounting**>.
i. Flow-Control Fitting: Required.
j. Operation: [**Automatic recovery**]<**Insert operation**>.
k. Electrical Characteristics:

1) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2) Power Requirement: [**120 V ac**]<**Insert power**>.
3) Full-Load Amperes: <**Insert number**> A.
4) Minimum Circuit Ampacity: <**Insert number**> A.
5) Maximum Overcurrent Protection: <**Insert number**> A.

l. Waste Grease Receptacle: [**Furnished by Owner**]<**Insert description**>.

2.3 INTERCEPTORS, OIL

A. Interceptors, Oil - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Concrete Products Co.**]
b. [**Copeland Precast, Inc.**]
c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
d. [**Wieser Concrete**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Concrete Products Co.**]
b. [**Copeland Precast, Inc.**]
c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
d. [**Wieser Concrete**]
e. <**Insert manufacturer's name**>

3. Standard:

a. ASTM C913.
b. [**Specific requirements of the Authority Having Jurisdiction**].

4. Description: Factory-fabricated oil interceptor with removable sediment bucket or strainer, baffles,

vents, and flow-control fitting on inlet.

5. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain oil and to permit wastewater flow.
6. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
7. Structural Design Loads:

    a. Light-Traffic Load: Comply with ASTM C890, A-8.
    b. Medium-Traffic Load: Comply with ASTM C890, A-12.
    c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
    d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into interceptor walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
10. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser, with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover.

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**][**OIL INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

12. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
13. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Capacity: <**Insert gal. (L)**>.
    d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet: Integral.
    g. Cleanout: Integral[**or field installed on outlet**].
    h. Vent Pipe Size: <**Insert NPS (DN)**>.
    i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    j. Flow-Control Fitting: Required.

B. Interceptors, Oil - Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]
    f. [**Wade; a subsidiary of McWane Inc.**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]
    f. [**Wade; a subsidiary of McWane Inc.**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

3. Description: Factory-fabricated oil interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Steel.
5. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
6. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
7. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
8. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
9. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C890 [**A-03, walkway**]<**Insert loading type**> load.
10. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
11. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Capacity: <**Insert gal. (L)**>.
    d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet Required: Integral.

g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

C. Interceptors, Oil - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**MIFAB, Inc**]
   b. [**Striem**]
   c. [**Town & Country Plastics, Inc**]
   d. [**Xerxes by Shawcor Ltd.**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MIFAB, Inc**]
   b. [**Striem**]
   c. [**Town & Country Plastics, Inc**]
   d. [**Xerxes by Shawcor Ltd.**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated oil interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Plastic.
5. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
6. Extension: Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
7. Cover: Plastic[**with steel reinforcement to provide ASTM C890**][**A-03, walkway**]<**Insert loading type**> load.
8. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
9. Capacities and Characteristics:

   a. Length by Width by Depth: <**Insert inches (mm)**>.
   b. Flow Rate: <**Insert gpm (L/s)**>.
   c. Capacity: <**Insert gal. (L)**>.
   d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

      1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
      2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

   e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

      1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

   f. Trapped Outlet: Integral.

g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

2.4 INTERCEPTORS, SAND

A. Interceptors, Sand - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advance Concrete Products Co.**]
   b. [**Copeland Precast, Inc.**]
   c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   d. [**Wieser Concrete**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advance Concrete Products Co.**]
   b. [**Copeland Precast, Inc.**]
   c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   d. [**Wieser Concrete**]
   e. <**Insert manufacturer's name**>

3. Standard:

   a. ASTM C913.
   b. [**Specific requirements of the Authority Having Jurisdiction**].

4. Description: Factory-fabricated sand interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
5. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain sand and to permit wastewater flow.
6. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
7. Structural Design Loads:

   a. Light-Traffic Load: Comply with ASTM C890, A-8.
   b. Medium-Traffic Load: Comply with ASTM C890, A-12.
   c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
   d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into interceptor walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-**

inch (300- to 400-mm) intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [60 inches (1500 mm)]<**Insert dimension**>.

10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover.

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**][**SAND INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

12. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Capacity: <**Insert gal. (L)**>.
    d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    e. Trapped Outlet: Integral.
    f. Cleanout: Integral[**or field installed on outlet**].
    g. Vent Pipe Size: <**Insert NPS (DN)**>.
    h. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    i. Flow-Control Fitting: Required.

B. Interceptors, Sand - Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]
    f. [**Wade; a subsidiary of McWane Inc.**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]

f. [**Wade; a subsidiary of McWane Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sand interceptor, steel body and inlet grate; with settlement chamber and removable basket or strainer made for removing and retaining sand from wastewater.
4. Body Material: Steel.
5. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resisting coating.
6. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resisting coating.
7. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
8. Grate: Cast iron or steel with reinforcement to provide ASTM C890 [**A-03, walkway**]<**Insert loading type**> load.
9. Capacities and Characteristics:

a. Length by Width by Depth: <**Insert inches (mm)**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. Capacity: <**Insert gal. (L)**>.
d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

e. Trapped Outlet: Integral.
f. Cleanout: Integral[**or field installed on outlet**].
g. Vent Pipe Size: <**Insert NPS (DN)**>.
h. Installation Position: [**Top flush with grade**]<**Insert position**>.

C. Interceptors, Sand - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MIFAB, Inc**]
b. [**Striem**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MIFAB, Inc**]
b. [**Striem**]
c. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sand interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Plastic.
5. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
6. Extension: Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
7. Cover: Plastic[**with steel reinforcement to provide ASTM C890**][**A-03, walkway**]<**Insert loading type**> load.
8. Capacities and Characteristics:

a. Length by Width by Depth: <**Insert inches (mm)**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. Capacity: <**Insert gal. (L)**>.
d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

f. Trapped Outlet: Integral.
g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

2.5 INTERCEPTORS, SAND AND OIL

A. Interceptors, Sand and Oil - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Copeland Precast, Inc.**]
b. [**Oldcastle Infrastructure Inc.; CRH Americas**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Copeland Precast, Inc.**]
b. [**Oldcastle Infrastructure Inc.; CRH Americas**]
c. <**Insert manufacturer's name**>

3. Standard:

a. ASTM C913.
b. [**Specific requirements of the Authority Having Jurisdiction**].

4. Description: Factory-fabricated sand and oil interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
5. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain sand and to permit wastewater flow.
6. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
7. Structural Design Loads:

a. Light-Traffic Load: Comply with ASTM C890, A-8.
b. Medium-Traffic Load: Comply with ASTM C890, A-12.

c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into interceptor walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
10. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover.

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**][**SAND & OIL INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

12. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
13. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Capacity: <**Insert gal. (L)**>.
    d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    e. Trapped Outlet: Integral.
    f. Cleanout: Integral[**or field installed on outlet**].
    g. Vent Pipe Size: <**Insert NPS (DN)**>.
    h. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    i. Flow-Control Fitting: Required.

B. Interceptors, Sand and Oil - Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]
    f. [**Wade; a subsidiary of McWane Inc.**]
    g. [**WATTS; A Watts Water Technologies Company**]

h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**ParkUSA; a Northwest Pipe Company**]
e. [**Rockford Separators**]
f. [**Wade; a subsidiary of McWane Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sand and oil interceptor with removable basket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Steel.
5. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
6. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
7. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
8. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
9. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C890 [**A-03, walkway**]<**Insert loading type**> load.
10. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
11. Capacities and Characteristics:

a. Length by Width by Depth: <**Insert inches (mm)**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. Capacity: <**Insert gal. (L)**>.
d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

f. Trapped Outlet: Integral.
g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

C. Interceptors, Sand and Oil - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**MIFAB, Inc**]
b. [**Striem**]
c. [**Town & Country Plastics, Inc**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MIFAB, Inc**]
b. [**Striem**]
c. [**Town & Country Plastics, Inc**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sand and oil interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Plastic.
5. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
6. Extension: Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
7. Cover: Plastic[**with steel reinforcement to provide ASTM C890**][**A-03, walkway**]<**Insert loading type**> load.
8. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
9. Capacities and Characteristics:

a. Length by Width by Depth: <**Insert inches (mm)**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. Capacity: <**Insert gal. (L)**>.
d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

f. Trapped Outlet: Integral.
g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

2.6 INTERCEPTORS, SOLIDS

A. Interceptors, Solids - Cast Iron, Cast Aluminum, or Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Rockford Separators**]
e. [**Wade; a subsidiary of McWane Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Rockford Separators**]
e. [**Wade; a subsidiary of McWane Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

3. Description: Factory-fabricated solids interceptor made for removing and retaining [**lint**][**sediment**]<**Insert solid**> from wastewater.
4. Body Material: Cast iron, cast aluminum or steel.
5. Interior Separation Device: [**Baffles**][**Screens**]<**Insert device**>.
6. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
7. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
8. Inlet, and Outlet Piping Connections: Threaded unless otherwise indicated.
9. Body Dimensions: <**Insert dimensions**>.
10. Flow Rate: <**Insert gpm (L/s)**>.
11. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.
12. Mounting: [**Above floor**][**Inline**]<**Insert mounting**>.

B. Interceptors, Solids - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashland PolyTrap**]
b. [**MIFAB, Inc**]
c. [**Striem**]
d. [**Town & Country Plastics, Inc**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashland PolyTrap**]

b. [**MIFAB, Inc**]
c. [**Striem**]
d. [**Town & Country Plastics, Inc**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated interceptor made for removing and retaining [**lint**][**sediment**]<**Insert solid**> from wastewater.
4. Body Material: Plastic.
5. Interior Separation Device: [**Baffles**][**Screens**]<**Insert device**>.
6. Inlet, and Outlet Piping Connections: Threaded unless otherwise indicated.
7. Body Dimensions: <**Insert dimensions**>.
8. Flow Rate: <**Insert gpm (L/s)**>.
9. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.
10. Mounting: [**Above floor**][**Inline**]<**Insert mounting**>.

2.7 MANHOLE RISERS, FRAMES, AND COVERS

A. Precast-Concrete Manhole Risers: [**ASTM C478 (ASTM C478M)**][**ASTM C913**], with rubber-gasket joints.

1. Structural Design Loads:

a. Light-Traffic Load: Comply with ASTM C890, A-8.
b. Medium-Traffic Load: Comply with ASTM C890, A-12.
c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
d. Walkway Load: Comply with ASTM C890, A-03.

2. Length: From top of underground concrete structure to grade.
3. Riser Sections: **3-inch (75-mm)** minimum thickness and [**36-inch (915-mm)**]<**Insert dimension**> diameter.
4. Top Section: Eccentric cone unless otherwise indicated. Include top of cone to match grade ring size.
5. Gaskets: **ASTM C443 (ASTM C443M)**, rubber.
6. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals.

B. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, diameter matching manhole frame and cover, and height as required to adjust the manhole frame and cover to indicated elevation and slope.

C. Manhole Frames and Covers: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover.

1. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
2. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
3. Include indented top design with lettering cast into cover, using wording equivalent to the following:

a. Grease Interceptors in Sanitary Sewerage System: "[**INTERCEPTOR**][**GREASE INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

b. Oil Interceptors in Sanitary Sewerage System: "[**INTERCEPTOR**][**OIL INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.
c. Sand Interceptors in Sanitary Sewerage System: "[**INTERCEPTOR**][**SAND INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.
d. Sand and Oil Interceptors in Sanitary Sewerage System: "[**INTERCEPTOR**][**SAND & OIL INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

2.8 SAMPLING PORTS

A. Sampling Ports - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ParkUSA; a Northwest Pipe Company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ParkUSA; a Northwest Pipe Company**]
   b. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sampling port.
4. Body Material: Precast concrete or Class I/II concrete with design strength of **4500 psi (31,026 kPa)** at 28 days.
5. Location: Below grade.
6. Body Interior Diameter: [**15-inch (381-mm)**][**18-inch (458-mm)**][**24-inch (610-mm)**]<**Insert dimension**> diameter.
7. Structural Design Loads:

   a. Light-Traffic Load: Comply with ASTM C890, A-8.
   b. Medium-Traffic Load: Comply with ASTM C890, A-12.
   c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
   d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into walls, for each pipe connection.
9. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover.
10. Manhole Frames and Covers:

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**SAMPLING WELL/PORT**]" <**Insert lettering**>.

B. Sampling Ports - Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ParkUSA; a Northwest Pipe Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ParkUSA; a Northwest Pipe Company**]
b. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sampling port.
4. Body Material: Type 304 stainless steel conforming with ASTM A480/A480M.
5. Body Diameter: [**15-inch (381-mm)**][**24-inch (610-mm)**]<**Insert dimension**> diameter.
6. Location: [**Above grade**][**In accessible pit**].
7. Cover: Removable lid with securing bolts and gasket.

a. Include indented top design with lettering cast into cover, using wording equivalent to "[**SAMPLING WELL/PORT**]" <**Insert lettering**>.

C. Sampling Ports - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MIFAB, Inc**]
b. [**Schier Products Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MIFAB, Inc**]
b. [**Schier Products Company**]
c. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sampling port.
4. Body Material: Seamless rotationally molded polyethylene or molded HDPE.
5. Body Diameter: [**15-inch (381-mm)**][**18-inch (458-mm)**][**24-inch (610-mm)**]<**Insert dimension**> diameter.
6. Location: [**Above grade**][**In accessible pit**][**Below grade**].
7. Cover: Water and gas-tight seal.

a. Include indented top design with lettering cast into cover, using wording equivalent to "[**SAMPLING WELL/PORT**]" <**Insert lettering**>.

8. Body Extension: <**Insert inches (mm)**> height.
9. Structural Design Loads:

a. Light-Traffic Load: Comply with ASTM C890, A-8.
b. Medium-Traffic Load: Comply with ASTM C890, A-12.

c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
d. Walkway Load: Comply with ASTM C890, A-03.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF SANITARY WASTE INTERCEPTORS

A. Equipment Mounting:

1. Install [**grease interceptors**][**grease-removal devices**][**and**][**solids interceptors**] on cast-in-place concrete equipment base(s).
2. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Install precast-concrete interceptors in accordance with ASTM C891.

C. Set interceptors level and plumb.

D. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

E. Set tops of manhole frames and covers flush with finished surface in pavements.

1. Set tops [**3 inches (75 mm)**]<**Insert dimension**> above finish surface elsewhere unless otherwise indicated.

F. Set tops of grating frames and grates flush with finished surface.

G. Set [**metal**][**and**][**plastic**] interceptors level and plumb.

H. Set tops of metal interceptor covers flush with finished surface in pavements.

1. Set tops [**3 inches (75 mm)**]<**Insert dimension**> above finish surface elsewhere unless otherwise indicated.

I. Install captured waste oil piping and waste oil storage tanks in accordance with the requirements of the Authority Having Jurisdiction.

J. Install grease interceptors, including trapping, venting, and flow-control fitting, in accordance with authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

K. Install grease-removal devices on floor. Install trap, vent, and flow-control fitting in accordance with authorities having jurisdiction.

1. Install control panel adjacent to unit unless otherwise indicated.

L. Install oil and sand & oil interceptors, including trapping, venting, and flow-control fitting, in accordance with authorities having jurisdiction and with clear space for servicing.

1. Coordinate captured waste oil storage tank and/or gravity drain with the Authority Having Jurisdiction.

M. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet.

1. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inches (13 mm)** high.

3.5 IDENTIFICATION

A. Identification materials and installation are specified in Section 312000 "Earth Moving."

1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
2. Use warning tapes or detectable warning tape over ferrous piping.
3. Use detectable warning tape over nonferrous piping and over edges of underground structures.

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or

near each of the following:

1. Grease interceptors.
2. Grease-removal devices.
3. Oil and sand, and oil interceptors.
4. Solids interceptors.
5. Sampling ports.

3.6 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.

B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 22 13 23 00

Task	Specification	Specification Description
22 13 23 00	22 13 19 00	Sanitary Waste Piping Specialties
22 13 23 00	22 13 00 00	Facility Gray-Water Storage Tanks

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SECTION 22 13 29 00 - SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible effluent pumps.
2. Submersible sewage pumps.
3. Wet-pit-volute sewage pumps.
4. Sewage-pump, reverse-flow assemblies.
5. Sewage-pump basins and basin covers.
6. Progressing-cavity sewage pumps.
7. Packaged, submersible sewage-pump units.
8. Packaged wastewater-pump units.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for applications in storm-drainage systems.
2. Section 333200 "Site Packaged Sewage Pumping Stations" for applications in site-construction sewage pumping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. [**Include construction details, material descriptions, dimensions of individual components and profiles.**][**Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.**]

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.2 SUBMERSIBLE EFFLUENT PUMPS

A. Submersible, Fixed-Position, Single-Seal Effluent Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Bell & Gossett; a Xylem brand**]
    d. [**Flo Fab Inc**]
    e. [**Goulds Water Technology; a Xylem brand**]
    f. [**GRUNDFOS CBS Inc.**]
    g. [**Liberty Pumps**]
    h. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
    i. [**Pentair Aurora; Pentair Pump Group**]
    j. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
    k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
    l. [**Stancor, Inc**]
    m. [**WILO-EMU USA LLC**]
    n. [**Zoeller Company**]
    o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Bell & Gossett; a Xylem brand**]
    d. [**Flo Fab Inc**]

e. [**Goulds Water Technology; a Xylem brand**]
f. [**GRUNDFOS CBS Inc.**]
g. [**Liberty Pumps**]
h. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
i. [**Pentair Aurora; Pentair Pump Group**]
j. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
l. [**Stancor, Inc**]
m. [**WILO-EMU USA LLC**]
n. [**Zoeller Company**]
o. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested effluent-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to

building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Submersible, Fixed-Position, Double-Seal Effluent Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABS; Cardo Flow Solutions**]
   b. [**BJM Pumps, LLC**]
   c. [**Federal Pump Corp**]
   d. [**HOMA Pump Technology Inc.**]
   e. [**KSB Inc.**]
   f. [**Liberty Pumps**]
   g. [**Pentair Aurora; Pentair Pump Group**]
   h. [**PX Pumps USA**]
   i. [**Stancor, Inc**]
   j. [**Tsurumi America, Inc.**]
   k. [**WILO-EMU USA LLC**]
   l. [**Zoeller Company**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABS; Cardo Flow Solutions**]
   b. [**BJM Pumps, LLC**]
   c. [**Federal Pump Corp**]
   d. [**HOMA Pump Technology Inc.**]
   e. [**KSB Inc.**]
   f. [**Liberty Pumps**]
   g. [**Pentair Aurora; Pentair Pump Group**]
   h. [**PX Pumps USA**]
   i. [**Stancor, Inc**]
   j. [**Tsurumi America, Inc.**]
   k. [**WILO-EMU USA LLC**]
   l. [**Zoeller Company**]
   m. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested effluent-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.

8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

C. Submersible, Quick-Disconnect, Single-Seal Effluent Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Liberty Pumps**]
    b. [**Pentair Aurora; Pentair Pump Group**]
    c. [**Stancor, Inc**]
    d. [**WILO-EMU USA LLC**]
    e. [**Zoeller Company**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Liberty Pumps**]
b. [**Pentair Aurora; Pentair Pump Group**]
c. [**Stancor, Inc**]
d. [**WILO-EMU USA LLC**]
e. [**Zoeller Company**]
f. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

13. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

D. Submersible, Quick-Disconnect, Double-Seal Effluent Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABS; Cardo Flow Solutions**]
    b. [**Chicago Pump Company; Grundfos Pumps Corporation**]
    c. [**Federal Pump Corp**]
    d. [**Flygt; a brand of Xylem Inc.**]
    e. [**HOMA Pump Technology Inc.**]
    f. [**Liberty Pumps**]
    g. [**Pentair Aurora; Pentair Pump Group**]
    h. [**PX Pumps USA**]
    i. [**Stancor, Inc**]
    j. [**Tsurumi America, Inc.**]
    k. [**WILO-EMU USA LLC**]
    l. [**Zoeller Company**]
    m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABS; Cardo Flow Solutions**]
    b. [**Chicago Pump Company; Grundfos Pumps Corporation**]
    c. [**Federal Pump Corp**]
    d. [**Flygt; a brand of Xylem Inc.**]
    e. [**HOMA Pump Technology Inc.**]
    f. [**Liberty Pumps**]
    g. [**Pentair Aurora; Pentair Pump Group**]
    h. [**PX Pumps USA**]
    i. [**Stancor, Inc**]
    j. [**Tsurumi America, Inc.**]
    k. [**WILO-EMU USA LLC**]
    l. [**Zoeller Company**]
    m. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.

5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

14. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump

during connection of flanges.

e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

E. Capacities and Characteristics:

1. Unit Capacity: <**Insert value**> **gpm (L/min.)**.
2. Number of Pumps: [**One**][**Two**]<**Insert value**>.
3. Each Pump:

a. Capacity: <**Insert value**> **gpm (L/min.)**.
b. Solids Handling Capability: [**Not applicable**][**2 inches (50 mm) minimum**][**2-1/2 inches (65 mm) minimum**][**3 inches (75 mm) minimum**]<**Insert inches (mm) minimum**>.
c. Total Dynamic Head: <**Insert value**>**feet (kPa)**.
d. Speed: <**Insert rpm**>.
e. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
f. Motor Horsepower: <**Insert value**> hp.
g. Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
2) Phases: [**Single**][**Three**].
3) Hertz: 60.

4. Unit Electrical Characteristics:

a. Full-Load Amperes: <**Insert value**> A.
b. Minimum Circuit Ampacity: <**Insert value**> A.
c. Maximum Overcurrent Protection: <**Insert value**> A.

2.3 SUBMERSIBLE SEWAGE PUMPS

A. Submersible, Fixed-Position, Single-Seal Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**EBARA Pumps Americas Corp.**]
d. [**Flo Fab Inc**]
e. [**Flygt; a brand of Xylem Inc.**]
f. [**Goulds Water Technology; a Xylem brand**]
g. [**GRUNDFOS CBS Inc.**]
h. [**Liberty Pumps**]
i. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
j. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
k. [**Peerless Pump Company**]
l. [**Pentair Aurora; Pentair Pump Group**]
m. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
n. [**Swaby Manufacturing Company**]
o. [**Weil Pump; a Wilo Company**]

p. [**Weinman; a Crane Pumps & Systems brand**]
q. [**WILO-EMU USA LLC**]
r. [**Zoeller Company**]
s. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**EBARA Pumps Americas Corp.**]
d. [**Flo Fab Inc**]
e. [**Flygt; a brand of Xylem Inc.**]
f. [**Goulds Water Technology; a Xylem brand**]
g. [**GRUNDFOS CBS Inc.**]
h. [**Liberty Pumps**]
i. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
j. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
k. [**Peerless Pump Company**]
l. [**Pentair Aurora; Pentair Pump Group**]
m. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
n. [**Swaby Manufacturing Company**]
o. [**Weil Pump; a Wilo Company**]
p. [**Weinman; a Crane Pumps & Systems brand**]
q. [**WILO-EMU USA LLC**]
r. [**Zoeller Company**]
s. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sewage-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.

e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Submersible, Fixed-Position, Double-Seal Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABS; Cardo Flow Solutions**]
b. [**Barnes; a Crane Pumps & Systems brand**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**BJM Pumps, LLC**]
e. [**Chicago Pump Company; Grundfos Pumps Corporation**]
f. [**E.I.M. Electric Co., Ltd.**]
g. [**EBARA Pumps Americas Corp.**]
h. [**Federal Pump Corp**]
i. [**Flygt; a brand of Xylem Inc.**]
j. [**Goulds Water Technology; a Xylem brand**]
k. [**HOMA Pump Technology Inc.**]
l. [**KSB Inc.**]
m. [**Liberty Pumps**]
n. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
o. [**Pentair Aurora; Pentair Pump Group**]
p. [**PX Pumps USA**]
q. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
r. [**Stancor, Inc**]
s. [**Swaby Manufacturing Company**]
t. [**Weil Pump; a Wilo Company**]
u. [**Weinman; a Crane Pumps & Systems brand**]
v. [**WILO-EMU USA LLC**]
w. [**Zoeller Company**]
x. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**ABS; Cardo Flow Solutions**]
b. [**Barnes; a Crane Pumps & Systems brand**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**BJM Pumps, LLC**]
e. [**Chicago Pump Company; Grundfos Pumps Corporation**]
f. [**E.I.M. Electric Co., Ltd.**]
g. [**EBARA Pumps Americas Corp.**]
h. [**Federal Pump Corp**]
i. [**Flygt; a brand of Xylem Inc.**]
j. [**Goulds Water Technology; a Xylem brand**]
k. [**HOMA Pump Technology Inc.**]
l. [**KSB Inc.**]
m. [**Liberty Pumps**]
n. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
o. [**Pentair Aurora; Pentair Pump Group**]
p. [**PX Pumps USA**]
q. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
r. [**Stancor, Inc**]
s. [**Swaby Manufacturing Company**]
t. [**Weil Pump; a Wilo Company**]
u. [**Weinman; a Crane Pumps & Systems brand**]
v. [**WILO-EMU USA LLC**]
w. [**Zoeller Company**]
x. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sewage-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.

e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

C. Submersible, Quick-Disconnect, Single-Seal Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EBARA Pumps Americas Corp.**]
b. [**Flygt; a brand of Xylem Inc.**]
c. [**Gorman-Rupp Company (The)**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**Liberty Pumps**]
f. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
g. [**Pentair Aurora; Pentair Pump Group**]
h. [**Swaby Manufacturing Company**]
i. [**Weil Pump; a Wilo Company**]
j. [**WILO-EMU USA LLC**]
k. [**Zoeller Company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EBARA Pumps Americas Corp.**]
b. [**Flygt; a brand of Xylem Inc.**]
c. [**Gorman-Rupp Company (The)**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**Liberty Pumps**]
f. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
g. [**Pentair Aurora; Pentair Pump Group**]
h. [**Swaby Manufacturing Company**]
i. [**Weil Pump; a Wilo Company**]

j. [**WILO-EMU USA LLC**]
k. [**Zoeller Company**]
l. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

13. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

D. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABS; Cardo Flow Solutions**]
b. [**Barnes; a Crane Pumps & Systems brand**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**BJM Pumps, LLC**]
e. [**Chicago Pump Company; Grundfos Pumps Corporation**]
f. [**E.I.M. Electric Co., Ltd.**]
g. [**EBARA Pumps Americas Corp.**]
h. [**Federal Pump Corp**]
i. [**Flygt; a brand of Xylem Inc.**]
j. [**Gorman-Rupp Company (The)**]
k. [**Goulds Water Technology; a Xylem brand**]
l. [**HOMA Pump Technology Inc.**]
m. [**KSB Inc.**]
n. [**Liberty Pumps**]
o. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
p. [**Pentair Aurora; Pentair Pump Group**]
q. [**PX Pumps USA**]
r. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
s. [**Stancor, Inc**]
t. [**Swaby Manufacturing Company**]
u. [**Tsurumi America, Inc.**]
v. [**Weil Pump; a Wilo Company**]
w. [**Weinman; a Crane Pumps & Systems brand**]
x. [**WILO-EMU USA LLC**]
y. [**Zoeller Company**]
z. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABS; Cardo Flow Solutions**]
b. [**Barnes; a Crane Pumps & Systems brand**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**BJM Pumps, LLC**]
e. [**Chicago Pump Company; Grundfos Pumps Corporation**]
f. [**E.I.M. Electric Co., Ltd.**]

g. [**EBARA Pumps Americas Corp.**]
h. [**Federal Pump Corp**]
i. [**Flygt; a brand of Xylem Inc.**]
j. [**Gorman-Rupp Company (The)**]
k. [**Goulds Water Technology; a Xylem brand**]
l. [**HOMA Pump Technology Inc.**]
m. [**KSB Inc.**]
n. [**Liberty Pumps**]
o. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
p. [**Pentair Aurora; Pentair Pump Group**]
q. [**PX Pumps USA**]
r. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
s. [**Stancor, Inc**]
t. [**Swaby Manufacturing Company**]
u. [**Tsurumi America, Inc.**]
v. [**Weil Pump; a Wilo Company**]
w. [**Weinman; a Crane Pumps & Systems brand**]
x. [**WILO-EMU USA LLC**]
y. [**Zoeller Company**]
z. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
4. Pump type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA

250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

14. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

E. Submersible, Quick-Disconnect, Grinder Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABS; Cardo Flow Solutions**]
b. [**Alyan Pump Company**]
c. [**Barnes; a Crane Pumps & Systems brand**]
d. [**BJM Pumps, LLC**]
e. [**EBARA Pumps Americas Corp.**]
f. [**HOMA Pump Technology Inc.**]
g. [**Liberty Pumps**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**Stancor, Inc**]
j. [**Tsurumi America, Inc.**]
k. [**Vaughan Co., Inc.**]
l. [**Weil Pump; a Wilo Company**]
m. [**WILO-EMU USA LLC**]
n. [**Zoeller Company**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABS; Cardo Flow Solutions**]
b. [**Alyan Pump Company**]
c. [**Barnes; a Crane Pumps & Systems brand**]
d. [**BJM Pumps, LLC**]
e. [**EBARA Pumps Americas Corp.**]
f. [**HOMA Pump Technology Inc.**]
g. [**Liberty Pumps**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**Stancor, Inc**]
j. [**Tsurumi America, Inc.**]
k. [**Vaughan Co., Inc.**]
l. [**Weil Pump; a Wilo Company**]
m. [**WILO-EMU USA LLC**]
n. [**Zoeller Company**]
o. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, grinder sewage-pump unit with guide-rail supports.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail supports.
6. Impeller: Bronze or stainless steel; statically and dynamically balanced, with stainless-steel cutter, grinder, or slicer assembly; capable of handling solids; and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

13. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

F. Submersible, Quick-Disconnect, Progressing-Cavity, Grinder Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barnes; a Crane Pumps & Systems brand**]
b. [**Environment One Corporation**]
c. [**Pentair Aurora; Pentair Pump Group**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Barnes; a Crane Pumps & Systems brand**]
b. [**Environment One Corporation**]
c. [**Pentair Aurora; Pentair Pump Group**]
d. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, progressing-cavity, grinder sewage-pump unit with guide-rail supports.
4. Pump Type: Submersible, progressing-cavity, single-screw rotary, grinder sewage pump as defined in HI 3.1-3.5.
5. Pump Body: [**Cast iron**]<**Insert material**>.
6. Pump Bearings: Radial and thrust types.
7. Pump Shaft: Steel.
8. Rotor: Stainless steel.
9. Stator: [**Buna-N**][**or**][**natural rubber**]<**Insert material**>.
10. Seal: Packing gland and mechanical types.
11. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
12. Controls, Rod-and-Float Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

14. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

15. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

G. Capacities and Characteristics:

1. Unit Capacity: <**Insert value**> **gpm (L/min.)**.
2. Number of Pumps: [**One**][**Two**]<**Insert value**>.
3. Each Pump:

a. Capacity: <**Insert value**> **gpm (L/min.)**.
b. Solids Handling Capability: [**Not applicable**][**2 inches (50 mm) minimum**][**2-1/2 inches (65 mm) minimum**][**3 inches (75 mm) minimum**]<**Insert inches (mm) minimum**>.
c. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
d. Speed: <**Insert rpm**>.
e. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.

f. Motor Horsepower: <**Insert value**> hp.
g. Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
2) Phases: [**Single**][**Three**].
3) Hertz: 60.

4. Unit Electrical Characteristics:

a. Full-Load Amperes: <**Insert value**> A.
b. Minimum Circuit Ampacity: <**Insert value**> A.
c. Maximum Overcurrent Protection: <**Insert value**> A.

2.4 WET-PIT-VOLUTE SEWAGE PUMPS

A. Description: Factory-assembled and -tested sewage-pump unit.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alyan Pump Company**]
2. [**Armstrong Fluid Technology**]
3. [**Chicago Pump Company; Grundfos Pumps Corporation**]
4. [**Federal Pump Corp**]
5. [**Flo Fab Inc**]
6. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
7. [**Peerless Pump Company**]
8. [**Pentair Aurora; Pentair Pump Group**]
9. [**Swaby Manufacturing Company**]
10. [**Tramco Pump Company**]
11. [**Vertiflo Pump Company**]
12. [**Weil Pump; a Wilo Company**]
13. [**Weinman; a Crane Pumps & Systems brand**]
14. [**Yeomans Chicago Corporation**]
15. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alyan Pump Company**]
2. [**Armstrong Fluid Technology**]
3. [**Chicago Pump Company; Grundfos Pumps Corporation**]
4. [**Federal Pump Corp**]
5. [**Flo Fab Inc**]
6. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
7. [**Peerless Pump Company**]
8. [**Pentair Aurora; Pentair Pump Group**]
9. [**Swaby Manufacturing Company**]
10. [**Tramco Pump Company**]
11. [**Vertiflo Pump Company**]
12. [**Weil Pump; a Wilo Company**]
13. [**Weinman; a Crane Pumps & Systems brand**]
14. [**Yeomans Chicago Corporation**]
15. <**Insert manufacturer's name**>

D. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.

E. Pump Casing: Cast iron, with open inlet and threaded or flanged connection for discharge piping.

F. Pump Shaft: [**Stainless steel**][**and**][**steel**].

G. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**and**][**ASTM B584, cast bronze**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.

H. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at **48-inch- (1200-mm-)** maximum intervals if basin depth is more than **48 inches (1200 mm)**, and grease-lubricated, ball-type thrust bearings.

I. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

J. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.

1. Revise piping configuration to accommodate reverse-flow assembly.

K. Support Plate: Cast iron or coated steel; strong enough to support pumps, motors, and controls. See "Sewage-Pump Basins and Basin Covers" Article for requirements.

L. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.

M. Motor: Single speed; grease-lubricated ball bearings and mounted on vertical, cast-iron pedestal.

N. Controls, Rod-and-Float Type:

1. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
2. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
5. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

O. Controls, Float- and Pressure-Switch Type:

1. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
2. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

P. Control-Interface Features:

1. Remote Alarm Contacts: For remote alarm interface.
2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

    a. On-off status of pump.
    b. Alarm status.

Q. Capacities and Characteristics:

1. Unit Capacity: <**Insert value**> **gpm (L/min.)**.
2. Number of Pumps: [**One**][**Two**]<**Insert value**>.
3. Each Pump:

    a. Capacity: <**Insert value**> **gpm (L/min.)**.
    b. Solids Handling Capability: [**2 inches (50 mm)**][**2-1/2 inches (65 mm)**][**3 inches (75 mm)**]<**Insert inches (mm)**> minimum.
    c. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
    d. Speed: <**Insert rpm**>.
    e. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
    f. Motor Horsepower: <**Insert value**> hp.
    g. Electrical Characteristics:

        1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
        2) Phases: [**Single**][**Three**].
        3) Hertz: 60.

4. Unit Electrical Characteristics:

    a. Full-Load Amperes: <**Insert value**> A.
    b. Minimum Circuit Ampacity: <**Insert value**> A.
    c. Maximum Overcurrent Protection: <**Insert value**> A.

2.5 SEWAGE-PUMP, REVERSE-FLOW ASSEMBLIES

A. Description: Factory-fabricated, sewage pump reverse-flow assembly for factory or field assembly and installation in sewage pump basin.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chicago Pump Company; Grundfos Pumps Corporation**]
2. [**Federal Pump Corp**]
3. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
4. [**Peerless Pump Company**]
5. [**Weil Pump; a Wilo Company**]
6. [**Yeomans Chicago Corporation**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Chicago Pump Company; Grundfos Pumps Corporation**]
2. [**Federal Pump Corp**]
3. [**PACO Pumps; Grundfos Pumps Corporation, USA**]

4. [**Peerless Pump Company**]
5. [**Weil Pump; a Wilo Company**]
6. [**Yeomans Chicago Corporation**]
7. <**Insert manufacturer's name**>

D. Components: Include the following corrosion-resistant-metal components:

1. Inlet Fitting: One combination inlet-overflow strainer fitting.
2. Valves: Two shutoff valves and two check valves.
3. Strainers: Two strainer housings with reverse-flow, self-flushing strainers.
4. Pipe and Fittings: Size and configuration required to connect to sewage pumps and piping.

2.6 SEWAGE-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: [**Cast iron**][**Fiberglass**][**Polyethylene**]<**Insert material**>.
2. Reinforcement: Mounting plates for pumps, fittings[**, guide-rail supports if used,**] and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:

1. Capacity: <**Insert value**> **gal. (L)**.
2. Diameter: <**Insert value**> **inches (mm)**.
3. Depth: <**Insert value**> **inches (mm)**.
4. Inlet No. 1:

    a. Drainage Pipe Size: <**Insert value**> **NPS (DN)**.
    b. Bottom of Sump to Centerline: <**Insert value**> **inches (mm)**.
    c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

5. Inlet No. 2:

    a. Drainage Pipe Size: <**Insert value**> **NPS (DN)**.
    b. Bottom of Sump to Centerline: <**Insert value**> **inches (mm)**.
    c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

6. Inlet No. 3:

    a. Drainage Pipe Size: <**Insert value**> **NPS (DN)**.
    b. Bottom of Sump to Centerline: <**Insert value**> **inches (mm)**.
    c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

7. Sidewall Outlet:

a. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
b. Bottom of Sump to Centerline: <**Insert value**> **inches (mm)**.
c. Type: [**Hubbed inside**][**Hubbed outside**]<**Insert type**>.

8. Cover Material: [**Cast iron**][**Steel with bituminous coating**][**Cast iron or steel with bituminous coating**]<**Insert material**>.
9. Cover Diameter: <**Insert value**> **inches (mm)**, but not less than outside diameter of basin top flange.
10. Manhole Required in Cover: [**Yes**][**No**].
11. Vent Size: <**Insert value**> **NPS (DN)**.

2.7 PROGRESSING-CAVITY SEWAGE PUMPS

A. Description: Factory-assembled and -tested, progressing-cavity, single-screw rotary pump as defined in HI 3.1-3.5.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Continental Pump Co.**]
2. [**Moyno, Inc.**]
3. [**Roper Pump Co.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Continental Pump Co.**]
2. [**Moyno, Inc.**]
3. [**Roper Pump Co.**]
4. <**Insert manufacturer's name**>

D. Pump Body: [**Cast iron**]<**Insert material**> with feet for base or floor installation.

E. Pump Bearings: Radial and thrust types.

F. Pump Shaft: Steel.

G. Rotor: [**Chrome-plated steel**]<**Insert material**>.

H. Stator: [**Buna-N**][**or**][**natural rubber**]<**Insert material**>.

I. Seals: Packing gland and mechanical types.

J. Coupling: Flexible.

K. Motor: Single speed; grease-lubricated ball bearings.

L. Capacities and Characteristics:

1. Capacity: <**Insert value**>**gal. (L/min.)**.
2. Solids Handling Capability: [**Not applicable**][**2 inches (50 mm) minimum**][**2-1/2 inches (65 mm) minimum**][**3 inches (75 mm) minimum**]<**Insert inches (mm) minimum**>.

3. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
4. Speed: <**Insert rpm**>.
5. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
6. Motor Horsepower: <**Insert value**> hp.
7. Electrical Characteristics:

    a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
    b. Phases: [**Single**][**Three**].
    c. Hertz: 60.

8. Unit Electrical Characteristics:

    a. Full-Load Amperes: <**Insert value**> A.
    b. Minimum Circuit Ampacity: <**Insert value**> A.
    c. Maximum Overcurrent Protection: <**Insert value**> A.

2.8 PACKAGED, SUBMERSIBLE SEWAGE-PUMP UNITS

A. Packaged, Submersible, Grinder, Sewage-Pump Units:

1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, grinder sewage-pump unit.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Environment One Corporation**]
    d. [**Goulds Water Technology; a Xylem brand**]
    e. [**Liberty Pumps**]
    f. [**Pentair Aurora; Pentair Pump Group**]
    g. [**SFA Saniflo USA**]
    h. [**Zoeller Company**]
    i. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Environment One Corporation**]
    d. [**Goulds Water Technology; a Xylem brand**]
    e. [**Liberty Pumps**]
    f. [**Pentair Aurora; Pentair Pump Group**]
    g. [**SFA Saniflo USA**]
    h. [**Zoeller Company**]
    i. <**Insert manufacturer's name**>

4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron.

6. Impeller: Stainless-steel grinder[**, cutter, or slicer**] type with shredding ring.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
8. Controls for Simplex Pump: Manufacturer's standard panel for one pump.
9. Controls for Duplex Pump: Automatic, with mechanical- or mercury-float switches and alternator.
10. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
11. Basin: Watertight[**plastic**] and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.

B. Packaged, Submersible, Nonclog, Sewage-Pump Units :

1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sewage-pump unit.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Bell & Gossett; a Xylem brand**]
    d. [**Glentronics, Inc.**]
    e. [**Goulds Water Technology; a Xylem brand**]
    f. [**GRUNDFOS CBS Inc.**]
    g. [**Liberty Pumps**]
    h. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
    i. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
    j. [**Pentair Aurora; Pentair Pump Group**]
    k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
    l. [**Zoeller Company**]
    m. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Bell & Gossett; a Xylem brand**]
    d. [**Glentronics, Inc.**]
    e. [**Goulds Water Technology; a Xylem brand**]
    f. [**GRUNDFOS CBS Inc.**]
    g. [**Liberty Pumps**]
    h. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
    i. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
    j. [**Pentair Aurora; Pentair Pump Group**]
    k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
    l. [**Zoeller Company**]
    m. <**Insert manufacturer's name**>

4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron.

6. Impeller: Brass or cast iron; statically and dynamically balanced, non-clog design, and capable of handling **2-inch- (50-mm-)** diameter solids.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
8. Controls for Simplex Pump: Manufacturer's standard panel for one pump.
9. Controls for Duplex Pump: Automatic, with mechanical- or mercury-float switches and alternator.
10. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
11. Basin: Watertight[**plastic**] and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.

C. Capacities and Characteristics:

1. System Capacity: <**Insert value**>**gal. (L/min.)**.
2. Number of Pumps: [**One**][**Two**].
3. Each Pump:

    a. Capacity: <**Insert value**>**gal. (L/min.)**.
    b. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
    c. Speed: <**Insert rpm**>.
    d. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
    e. Motor Horsepower: <**Insert value**> hp.
    f. Electrical Characteristics:

        1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
        2) Phases: [**Single**][**Three**].
        3) Hertz: 60.

4. Unit Electrical Characteristics:

    a. Full-Load Amperes: <**Insert value**> A.
    b. Minimum Circuit Ampacity: <**Insert value**> A.
    c. Maximum Overcurrent Protection: <**Insert value**> A.

5. Alternator Control Required: [**Yes**][**No**].
6. Basin:

    a. Dimensions: <**Insert values**>.
    b. Inlet Size: <**Insert value**> **NPS (DN)**.
    c. Bottom to Inlet Centerline: <**Insert value**> **inches (mm)**.
    d. Vent Size: <**Insert value**> **NPS (DN)**.

2.9 PACKAGED WASTEWATER-PUMP UNITS

A. Packaged, Wet-Pit-Volute, Wastewater-Pump Units:

1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, effluent-pump unit.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alyan Pump Company**]
b. [**Federal Pump Corp**]
c. [**Hartell Pumps; Milton Roy**]
d. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alyan Pump Company**]
b. [**Federal Pump Corp**]
c. [**Hartell Pumps; Milton Roy**]
d. <**Insert manufacturer's name**>

4. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Body and Impeller: Corrosion-resistant materials.
6. Motor: With built-in overload protection and mounted vertically on basin cover.
7. Power Cord: Three-conductor, waterproof cable of length required, but not less than **72 inches (1830 mm)** and with grounding plug and cable-sealing assembly for connection at pump.
8. Control: Float switch.
9. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
10. Basin: Watertight, aluminum, plastic, or coated steel with inlet pipe connection and gastight cover with vent and pump discharge connections.

B. Packaged, Submersible Wastewater-Pump Units:

1. Description: Factory-assembled and -tested, automatic-operation, effluent-pump unit with basin.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**ABS; Cardo Flow Solutions**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**GRUNDFOS CBS Inc.**]
f. [**Liberty Pumps**]
g. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
j. [**SFA Saniflo USA**]
k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
l. [**Zoeller Company**]
m. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**ABS; Cardo Flow Solutions**]
c. [**Bell & Gossett; a Xylem brand**]

d. [**Goulds Water Technology; a Xylem brand**]
e. [**GRUNDFOS CBS Inc.**]
f. [**Liberty Pumps**]
g. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
j. [**SFA Saniflo USA**]
k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
l. [**Zoeller Company**]
m. <**Insert manufacturer's name**>

4. Pump Type: Submersible, end-suction, single-stage, overhung-impeller, centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Body and Impeller: Corrosion-resistant materials.
6. Pump Seals: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
8. Power Cord: Three-conductor, waterproof cable of length required, but not less than **72 inches (1830 mm)** and with grounding plug and cable-sealing assembly for connection at pump.
9. Control: Float switch.
10. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
11. Basin: Watertight plastic with inlet pipe connection and gastight cover with vent and pump discharge connections.

C. Capacities and Characteristics:

1. Pump Capacity: <**Insert value**> **gpm (L/min.)**.
2. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
3. Speed: <**Insert rpm**>.
4. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
5. Motor Horsepower: <**Insert value**> hp.
6. Electrical Characteristics:

a. Volts: [**120**][**240**]<**Insert value**> V ac.
b. Phases: [**Single**][**Three**].
c. Hertz: 60.

7. Unit Electrical Characteristics:

a. Full-Load Amperes: <**Insert value**> A.
b. Minimum Circuit Ampacity: <**Insert value**> A.
c. Maximum Overcurrent Protection: <**Insert value**> A.

8. Basin:

a. Capacity: [**2 gal. (7.6 L)**][**4 gal. (15.1 L)**]<**Insert value**> minimum.
b. Inlet Connection: [**NPS 1-1/2 (DN 40)**]<**Insert pipe size**> minimum.
c. Vent Connection: [**NPS 1-1/2 (DN 40)**]<**Insert pipe size**> minimum.

2.10 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.3 INSTALLATION

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.
2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

B. Equipment Mounting:

1. Install progressing-cavity sewage pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

C. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <**Insert startup steps**>.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain[**controls and**] pumps.

END OF SECTION 22 13 29 00

Task	Specification	Specification Description
22 13 29 00	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 29 13	22 13 29 00	Sanitary Sewerage Pumps
22 13 29 13	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 29 16	22 13 29 00	Sanitary Sewerage Pumps
22 13 29 16	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 29 19	22 13 29 00	Sanitary Sewerage Pumps
22 13 29 19	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 29 33	22 13 29 00	Sanitary Sewerage Pumps
22 13 29 33	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 29 36	22 13 29 00	Sanitary Sewerage Pumps
22 13 29 36	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 33 00	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 36 00	22 13 00 00	Facility Gray-Water Storage Tanks

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SECTION 22 14 00 00 - FACILITY STORM-WATER RETENTION TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel, pressure, storm-water retention tanks.
2. Steel, nonpressure, storm-water retention tanks.
3. Insulated, steel, storm-water retention tanks.
4. Plastic, pressure, storm-water retention tanks.
5. Plastic, nonpressure, storm-water retention tanks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for storm-water retention tanks.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of storm-water retention tanks.
4. <**Insert list of products**>.

C. Delegated-Design Submittal: For storm-water retention tanks.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For facility storm-water retention tanks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design facility storm-water retention tanks.

B. Structural Performance: Facility storm-water retention tank, including structural reinforcement and foundation, shall be capable of withstanding the effects of dead and live gravity loads and winds of [**100 mph (161 km/h)**]<**Insert value**>.

C. Seismic Performance: Facility storm-water retention tank, including structural reinforcement and foundation, shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."

D. Thermal Movements: Storm-water retention tank, including structural reinforcement and foundation, shall allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**]<**Insert temperature change**>.

2.2 STEEL, PRESSURE, STORM-WATER RETENTION TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**Green Boiler Technologies**]
8. [**GSW Water Heating**]
9. [**HESCO Bastion Ltd.**]
10. [**Lochinvar, LLC**]
11. [**Precision Boilers**]

12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**Green Boiler Technologies**]
8. [**GSW Water Heating**]
9. [**HESCO Bastion Ltd.**]
10. [**Lochinvar, LLC**]
11. [**Precision Boilers**]
12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

1. Comply with AWWA D100, "Welded Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks," for welded-steel, surface-water retention tanks.

F. Manhole: Watertight, for tank more than [**36 inches (900 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.

2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

J. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

K. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.3 STEEL, NONPRESSURE, STORM-WATER RETENTION TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**RECO USA**]
4. [**Steel Tank and Fabricating Corporation (STAFCO)**]
5. [**Wood, John Co**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**RECO USA**]
4. [**Steel Tank and Fabricating Corporation (STAFCO)**]
5. [**Wood, John Co**]
6. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], nonpressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: Steel, constructed with welded joints.

1. Comply with AWWA D100, "Welded Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks," for welded-steel, surface-water retention tanks.

F. Manhole: Watertight, for tank more than [**36 inches (900 mm)**]<**Insert dimension**> in diameter.

G. Cover for Open Tank: [**Plastic**][**Steel, with lining same as or similar to tank lining and**] with shape

that encloses top of tank.

H. Tappings: Factory-fabricated[**stainless**] steel, welded to tank.

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

I. Specialties and Accessories: Include tappings in tank and the following:

1. Vacuum relief valve.
2. Free air vent with insect screen.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

J. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

K. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

L. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.4 INSULATED, STEEL, STORM-WATER RETENTION TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**GSW Water Heating**]
3. [**HESCO Bastion Ltd.**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Precision Boilers**]
7. [**PVI; A WATTS Brand**]
8. [**RBI**]
9. [**State Industries**]
10. [**Vaughn Thermal Corporation**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**GSW Water Heating**]
3. [**HESCO Bastion Ltd.**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Precision Boilers**]
7. [**PVI; A WATTS Brand**]

8. [**RBI**]
9. [**State Industries**]
10. [**Vaughn Thermal Corporation**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

C. Description: Steel, vertical, pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

1. Comply with AWWA D100, "Welded Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks," for welded-steel, surface-water retention tanks.

F. Manhole: Watertight, for tank more than [**36 inches (900 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

J. Insulation: Factory-installed fiberglass or polyurethane foam; surrounding entire tank except connections and other openings; suitable for tank operating temperature; and complying with ASHRAE/IES 90.1.

K. Jacket: Steel, with manufacturer's standard finish unless otherwise indicated.

2.5 PLASTIC, PRESSURE, STORM-WATER RETENTION TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]

3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]
3. <**Insert manufacturer's name**>

C. Description: Fiberglass-reinforced plastic (FRP), vertical, pressure-rated tank with cylindrical sidewalls.

D. Construction: [**ASME code, composite FRP**][**Composite FRP**], [**contact-molded**][**or**][**filament-wound**], thermosetting-resin tank for [**100-psig (690-kPa)**][**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

1. Comply with AWWA D120.

E. Manhole: Watertight, for tank more than [**36 inches (900 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

F. Tappings: Factory-fabricated, FRP flanged-end nozzle.

1. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

G. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.

H. Vertical Tank Supports: Factory-fabricated steel legs or FRP skirt attached by FRP brackets to tank sidewall.

2.6 PLASTIC, NONPRESSURE, STORM-WATER RETENTION TANKS

A. FRP Water Retention Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amprotec, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amprotec, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

3. Description: FRP, vertical, nonpressure-rated water tank.
4. Construction: [**ASTM D3299, filament-wound**][**or**][**ASTM D4097, contact-molded**] FRP.
5. Tappings: Factory-fabricated, FRP flanged-end nozzle.

a. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.

1) Exception: Tappings may be threaded FRP coupling integral with nozzle for connections for plastic piping.

b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting tank.
7. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.
8. Cover for Open Tank: Plastic, same as or similar to tank material and with shape that encloses top of tank.
9. Specialties and Accessories: Include tappings in tank and the following:

a. Vacuum relief valve.
b. Free air vent with insect screen.
c. Thermometer.
d. Gage glass, brass fittings, compression stops, and gage-glass guard.

B. PE Water Retention Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amprotec, Inc.**]
b. [**Assmann Corporation of America**]
c. [**Chem-Tainer Industries**]
d. [**Poly Processing Company**]
e. [**Premier Plastics Inc.**]
f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amprotec, Inc.**]
b. [**Assmann Corporation of America**]
c. [**Chem-Tainer Industries**]
d. [**Poly Processing Company**]
e. [**Premier Plastics Inc.**]

f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

3. Description: PE, vertical, flat-bottom, nonpressure-rated water tank.
4. Construction: ASTM D1998, molded PE.
5. Tappings: Factory-fabricated bulkhead fittings attached to tank.

   a. NPS 2 (DN 50) and Smaller: With female thread.
   b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting entire bottom of tank.
7. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.
8. Cover for Open Tank: Plastic, same as or similar to tank material and with shape that encloses top of tank.
9. Specialties and Accessories: Include tappings in tank and the following:

   a. Vacuum relief valve.
   b. Free air vent with insect screen.
   c. Thermometer.
   d. Gage glass, brass fittings, compression stops, and gage-glass guard.

2.7 PAINT MATERIALS

A. Paint: Comply with AWWA D102.

B. Primer: Tank fabricator's standard epoxy-polyamide paint.

C. Tank Shell Exterior Intermediate Paint: Tank fabricator's standard, two-component epoxy paint compatible with prime and finish paint. Intermediate coat shall have a slight color contrast with finish coat.

D. Tank Shell Exterior Finish Paint: Tank fabricator's standard urethane paint.

1. Color: [**As selected by Owner from tank manufacturer's paint chart**]<**Insert color**>.

2.8 SHOP PAINTING

A. Tank Shell Exterior Finish Coat: Factory coating according to AWWA D103.

PART 3 - EXECUTION

3.1 INSTALLATION OF STORM-WATER RETENTION TANKS

A. Install storm-water retention tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

1. Install horizontal tanks on [**concrete piers and factory-fabricated**][**fabricated steel supports and**] saddles.

B. Anchor tank supports and tanks to substrate.

1. Use steel or FRP straps over or around plastic tanks.

C. Install thermometers and pressure gages on water retention tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220500 "Common Work Results for Plumbing."

D. Install the following devices on tanks where indicated:

1. Pressure relief valves.
2. Temperature and pressure relief valves.
3. Vacuum relief valves.
4. Tank vents on nonpressure tanks.
5. Connections to accessories.

E. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 CONNECTIONS

A. Where installing piping adjacent to storm-water retention tanks, allow space for service and maintenance.

B. Connect water piping to water retention tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. Valves NPS 2 (DN 50) and Smaller: Gate valves or ball valves complying with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Valves NPS 2-1/2 (DN 65) and Larger: Gate valves or butterfly valves complying with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."
3. Drain Valves: **NPS 3/4 (DN 20)** gate valves or ball valves complying with requirements in Section 220523 "General-Duty Valves for Plumbing Piping." Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.
4. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 221116 "Domestic Water Piping."

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

END OF SECTION 22 14 00 00

SECTION 22 14 13 00 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Copper tube and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Specialty pipe fittings.
8. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for storm drainage pumps.
2. Section 334200 "Stormwater Conveyance" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Copper tube and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Specialty pipe fittings.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, sections, elevations, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certificate is based and their installation requirements.

C. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: [**10-foot head of water (30 kPa)**]<**Insert pressure**>.
2. Storm Drainage, Force-Main Piping: [**50 psig (345 kPa)**][**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**>.

B. Seismic Performance: Storm drainage piping and support and installation to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully functional after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A74.
3. Class: [**Service weight**][**and**][**Extra heavy**] cast iron.

D. Gaskets: ASTM C564, rubber.

E. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]

4. <**Insert manufacturer's name**>

C. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standards: ASTM A888 and CISPI 301.

D. Standard, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

3. Marked with CISPI collective trademark [**and NSF certification mark**].
4. Standards: ASTM C1277 and CISPI 310.
5. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]

d. [**Fernco Inc**]
e. [**Ideal Tridon Group**]
f. [**Matco-Norca**]
g. [**MIFAB, Inc**]
h. [**Mission Rubber Company, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**Dallas Specialty & Mfg. Co.**]
d. [**Fernco Inc**]
e. [**Ideal Tridon Group**]
f. [**Matco-Norca**]
g. [**MIFAB, Inc**]
h. [**Mission Rubber Company, LLC**]
i. <**Insert manufacturer's name**>

3. Standard: ASTM C1277 or ASTM C1540.
4. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MG Coupling**]
b. [**MIFAB, Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MG Coupling**]
b. [**MIFAB, Inc**]
c. <**Insert manufacturer's name**>

3. Standard: ASTM A1056.
4. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, standard-weight class. Include ends matching joining method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**U.S. Steel**]
b. [**Wheatland Tube; Zekelman Industries**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**U.S. Steel**]
b. [**Wheatland Tube; Zekelman Industries**]
c. <**Insert manufacturer's name**>

B. Cast-Iron Drainage Fittings: [**Galvanized,**]ASME B16.12, threaded.

C. Steel-Pipe Pressure Fittings:

1. Steel Pipe Nipples: [**Galvanized,**]ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: [**Galvanized,**]ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Smith-Cooper International**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Smith-Cooper International**]
d. <**Insert manufacturer's name**>

3. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping:

a. ASTM A536 ductile-iron castings.

b. ASTM A234/A234M forged-steel fittings.

2.6 COPPER TUBE AND FITTINGS

A. Copper Tube:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cambridge-Lee Industries, LLC**]
   b. [**Cerro Flow Products, LLC**]
   c. [**Wieland Copper Products, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cambridge-Lee Industries, LLC**]
   b. [**Cerro Flow Products, LLC**]
   c. [**Wieland Copper Products, LLC**]
   d. <**Insert manufacturer's name**>

3. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
4. Copper Tube, Drawn Temper: **ASTM B88, Type L and Type M (ASTM B88M, Type B and Type C)**.
5. Copper Tube, Annealed Temper: **ASTM B88, Type L (ASTM B88M, Type B)**.

B. Copper Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**NIBCO INC.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**NIBCO INC.**]
   b. <**Insert manufacturer's name**>

3. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
4. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
5. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
6. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

a. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.
b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.7 ABS PIPE AND FITTINGS

A. ABS Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

3. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
4. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.
5. Cellular-Core ABS Pipe: ASTM F1488, Schedule 40.

B. ABS Socket Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Charlotte Pipe and Foundry Company**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Charlotte Pipe and Foundry Company**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

3. Standard: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

4. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Solvent Cement: ASTM D2235.

1. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.8 PVC PIPE AND FITTINGS

A. PVC Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Charlotte Pipe and Foundry Company**]
   b. [**JM Eagle**]
   c. [**National Pipe and Plastic, Inc. (Oldcastle)**]
   d. [**North America Pipe Corporation**]
   e. [**Silver-line Plastics**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Charlotte Pipe and Foundry Company**]
   b. [**JM Eagle**]
   c. [**National Pipe and Plastic, Inc. (Oldcastle)**]
   d. [**North America Pipe Corporation**]
   e. [**Silver-line Plastics**]
   f. <**Insert manufacturer's name**>

3. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
4. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
5. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.

B. PVC Socket Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Charlotte Pipe and Foundry Company**]
b. [**NIBCO INC.**]
c. [**North America Pipe Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Charlotte Pipe and Foundry Company**]
b. [**NIBCO INC.**]
c. [**North America Pipe Corporation**]
d. <**Insert manufacturer's name**>

3. Standard: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
4. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Adhesive Primer: ASTM F656.

1. Adhesive primer shall have a VOC content of 550 g/L or less.
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

D. Solvent Cement: ASTM D2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.

2.9 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) <**Insert manufacturer's name**>

c. Standard: ASTM C1173.
d. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C564 rubber.
2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) <**Insert manufacturer's name**>

c. Standard: ASTM C1460.
d. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Cascade Waterworks Mfg. Co.**]
2) [**EBAA Iron Sales, Inc.**]
3) [**Ford Meter Box Company, Inc. (The)**]
4) [**JCM Industries, Inc**]
5) [**Romac Industries, Inc.**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Cascade Waterworks Mfg. Co.**]
2) [**EBAA Iron Sales, Inc.**]
3) [**Ford Meter Box Company, Inc. (The)**]
4) [**JCM Industries, Inc**]
5) [**Romac Industries, Inc.**]
6) <**Insert manufacturer's name**>

c. Standard: AWWA C219.
d. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
e. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].
f. Gasket Material: Natural or synthetic rubber.
g. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**A.Y. McDonald Mfg. Co.**]
2) [**HART Industrial Unions, LLC**]
3) [**Jomar Valve**]
4) [**Matco-Norca**]
5) [**WATTS; A Watts Water Technologies Company**]
6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**A.Y. McDonald Mfg. Co.**]
2) [**HART Industrial Unions, LLC**]
3) [**Jomar Valve**]

4) [**Matco-Norca**]
5) [**WATTS; A Watts Water Technologies Company**]
6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

c. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: [**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**]<**Insert pressure**>.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**WATTS; A Watts Water Technologies Company**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**WATTS; A Watts Water Technologies Company**]
2) <**Insert manufacturer's name**>

c. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: [**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**]<**Insert pressure and temperature**>.
4) End Connections: Solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advance Products & Systems, LLC**]
2) [**GPT; a division of EnPRO Industries**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advance Products & Systems, LLC**]
2) [**GPT; a division of EnPRO Industries**]
3) <**Insert manufacturer's name**>

c. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**>.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Matco-Norca**]
3) [**Precision Plumbing Products**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Matco-Norca**]
3) [**Precision Plumbing Products**]
4) <**Insert manufacturer's name**>

c. Description: Electroplated steel nipple.
d. Standards: ASTM F492, ASME B1.20.1.
e. Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert pressure and temperature**>.
f. End Connections: Male threaded or grooved.
g. Lining: Inert and noncorrosive, propylene.

2.10 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: [**High-density, crosslaminated polyethylene film of 0.004-inch (0.10-mm)**][**or**][**linear low-density polyethylene film of 0.008-inch (0.20-mm)**] minimum thickness.

C. Form: [**Sheet**][**or**][**tube**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

B. Install piping as indicated unless deviations from layout are approved on coordination drawings.

C. Install piping in concealed locations.

1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

L. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of drainage piping in direction of flow is prohibited.

M. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

N. Install piping at the following minimum slopes unless otherwise indicated.

1. Building Storm Drain: [**1/4 inch per foot (2 percent)**]<**Insert number**> downward in direction of

flow for piping NPS 3 (DN 80) and smaller; [1/8 inch per foot (2 percent)][1/4 inch per foot (2 percent)]<**Insert number**> downward in direction of flow for piping NPS 4 (DN 100) and larger.

2. Horizontal Storm Drainage Piping: [1/4 inch per foot (2 percent)]<**Insert number**> downward in direction of flow.

O. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Ch IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

P. Install steel piping in accordance with applicable plumbing code.

Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping in accordance with ASTM D2661.

S. Install aboveground PVC piping in accordance with ASTM D2665.

T. Install underground [**ABS**][**and**][**PVC**] piping in accordance with ASTM D2321.

U. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

V. Install force mains at elevations indicated.

W. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

2. Install cleanouts in storm drainage gravity-flow piping in accessible locations.

a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

3. Install drains in storm drainage gravity-flow piping.

a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

X. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Y. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

Z. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

AA. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
c. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendices.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendices.

I. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings [5 inches (125 mm)]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings [4 inches (100 mm)]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings [5 inches (125 mm)]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: [**Unshielded**][**Shielded**], nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [**nipples**][**unions**].
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [**flanges**][**flange kits**][**nipples**].
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installations are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install [**gate**][**full port ball valve**] for piping NS 2 (DN 50) and smaller.
3. Install [**gate**][**butterfly**]<**Insert type**> valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.[**Use normally closed type unless otherwise indicated.**]
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install [**carbon-steel**]<**Insert material**> pipe hangers for horizontal piping in noncorrosive environments.
2. Install [**stainless steel**][**fiberglass**] pipe hangers for horizontal piping in corrosive environments.
3. Install [**carbon-steel**]<**Insert material**> pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for [**cast-iron**][**galvanized-steel**][**and**][**copper**] soil [**tubing**][**and**][**piping**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [**ABS**][**and**][**PVC**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within **12 inches (300 mm)** of each fitting[**, valve,**] and coupling.

F. Support vertical [**cast-iron**][**galvanized steel**][**and**][**copper**][**tubing**][**and**][**piping**] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

G. Support vertical [**ABS**][**and**][**PVC**] piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves [**with cleanout cover flush with floor**][**in pit with pit cover flush with floor**]<**Insert description**>.
3. Comply with requirements for [**backwater valves**][**cleanouts**][**and**][**drains**] specified in Section 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

    a. Test storm drainage piping[**, except outside leaders,**] on completion of roughing-in.
    b. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water (30 kPa)**.
    c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
    d. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

3.11 PROTECTION

A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping [**NPS 6 (DN 150) and smaller**]<**Insert pipe size range**> is to be[**any of**] the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI,**][**heavy-duty,**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
6. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
7. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

C. Aboveground, storm drainage piping [**NPS 8 (DN 200) and larger**]<**Insert pipe size range**> is to be[

any of] the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI,**][**heavy-duty,**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

D. Underground storm drainage piping [**NPS 6 (DN 150) and smaller**]<**Insert pipe size range**> shall be[**any of**] the following:

1. [**Extra heavy**][**Service weight**], cast-iron soil pipe and fittings; [**gaskets; and gasketed**][**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI,**][**heavy-duty,**][**cast-iron,**] hubless-piping couplings; and coupled joints.
3. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

E. Underground, storm drainage piping [**NPS 8 (DN 200) and larger**]<**Insert pipe size range**> is to be[**any of**] the following:

1. [**Extra heavy**][**Service weight**], cast-iron soil pipe and fittings; [**gaskets; and gasketed**][**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI,**][**heavy-duty,**][**cast-iron,**] hubless-piping couplings; and coupled joints.
3. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

F. Aboveground storm drainage force mains [**NPS 1-1/2 and NPS 2 (DN 40 and DN 50)**]<**Insert pipe size range**> is to be[**any of**] the following:

1. Hard copper tube, **Type L (Type B)** copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains [**NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**]<**Insert pipe size range**> is to be[**any of**] the following:

1. Hard copper tube, **Type L (Type B)** copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Fitting-type transition couplings if dissimilar pipe materials.

END OF SECTION 22 14 13 00

Task	Specification	Specification Description
22 14 13 00	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 26 00	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 26 13	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 26 16	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 26 19	22 14 00 00	Facility Storm-Water Retention Tanks

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SECTION 22 14 29 00 - SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sump pumps - submersible.
2. Sump pumps - wet-pit volute.
3. Oil-sensing sump pumps and controllers.
4. Sump pumps - pedestal.
5. Sump-pump basins and basin covers.
6. Packaged drainage-pump units - submersible.

B. Related Requirements:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Sump pumps - submersible.
2. Sump pumps - wet-pit volute.
3. Oil-sensing sump pumps and controllers.
4. Sump pumps - pedestal.
5. Sump-pump basins and basin covers.
6. Packaged drainage-pump units - submersible.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls.

1. Indicate actual installed items by marking submittals with an arrow or box.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

1.5 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace sump pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of <**Insert components**>.
b. Deterioration of metals, metal finishes, and other materials beyond normal [**weathering**][**use**].
c. <**Insert conditions relating to specified products**>.
d. <**Insert failure modes**>.

2. Warranty Period: [**1**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of sump pump from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.3 SUMP PUMPS - SUBMERSIBLE

A. Sump Pumps - Submersible, Fixed Position, Single Seal: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Crane Pumps & Systems**]
c. [**Glentronics, Inc.**]
d. [**GRUNDFOS CBS Inc.**]

e. [**Industrial Flow Solutions**]
f. [**Liberty Pumps**]
g. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
j. [**Weil Pump; a Wilo Company**]
k. [**Xylem**]
l. [**Zoeller Company**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Crane Pumps & Systems**]
c. [**Glentronics, Inc.**]
d. [**GRUNDFOS CBS Inc.**]
e. [**Industrial Flow Solutions**]
f. [**Liberty Pumps**]
g. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
j. [**Weil Pump; a Wilo Company**]
k. [**Xylem**]
l. [**Zoeller Company**]
m. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sump-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**manufacturer's standard**]<**Insert material**> designed for clear wastewater handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

a. Motor Housing Fluid: [**Air**][**Oil**].

10. Capacities and Characteristics:

a. Unit Capacity: <**Insert gpm (L/min.)**>.
b. Number of Pumps: [**One**][**Two**]<**Insert number**>.
c. Each Pump:

1) Capacity: <**Insert gpm (L/min.)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Electrical Characteristics:

a) Motor Horsepower: <**Insert value**> hp.
b) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
c) Phases: [**Single**][**Three**].
d) Hertz: 60.

d. Unit Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**> A.
2) Minimum Circuit Ampacity: <**Insert value**> A.
3) Maximum Overcurrent Protection: <**Insert value**> A.

11. Controls, Rod-and-Float Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Sump Pumps - Submersible, Fixed Position, Double Seal: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EBARA Pumps Americas Corp.**]
b. [**GRUNDFOS CBS Inc.**]
c. [**Industrial Flow Solutions**]
d. [**Xylem**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**EBARA Pumps Americas Corp.**]
    b. [**GRUNDFOS CBS Inc.**]
    c. [**Industrial Flow Solutions**]
    d. [**Xylem**]
    e. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sump-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**manufacturer's standard**]<**Insert material**> designed for clear wastewater handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Capacities and Characteristics:

    a. Unit Capacity: <**Insert gpm (L/min.)**>.
    b. Number of Pumps: [**One**][**Two**]<**Insert number**>.
    c. Each Pump:

        1) Capacity: <**Insert gpm (L/min.)**>.
        2) Total Dynamic Head: <**Insert feet (kPa)**>.
        3) Speed: <**Insert rpm**>.
        4) Discharge Size: <**Insert NPS (DN)**>.
        5) Electrical Characteristics:

            a) Motor Horsepower: <**Insert value**> hp.
            b) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
            c) Phases: [**Single**][**Three**].
            d) Hertz: 60.

    d. Unit Electrical Characteristics:

        1) Full-Load Amperes: <**Insert value**> A.
        2) Minimum Circuit Ampacity: <**Insert value**> A.
        3) Maximum Overcurrent Protection: <**Insert value**> A.

12. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

14. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

2.4 SUMP PUMPS - WET-PIT VOLUTE

A. Sump Pumps - Wet-Pit Volute: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Pumps & Systems**]
b. [**Federal Pump Corp**]
c. [**Peerless Pump Company**]
d. [**Swaby Manufacturing Company**]
e. [**Tramco Pump Company**]
f. [**Vertiflo Pump Company**]
g. [**Weil Pump; a Wilo Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crane Pumps & Systems**]
b. [**Federal Pump Corp**]
c. [**Peerless Pump Company**]
d. [**Swaby Manufacturing Company**]
e. [**Tramco Pump Company**]
f. [**Vertiflo Pump Company**]
g. [**Weil Pump; a Wilo Company**]

h. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sump-pump unit.
4. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Cast iron, with strainer inlet and threaded connection for **NPS 2 (DN 50)** and smaller and flanged connection for **NPS 2-1/2 (DN 65)** and larger discharge piping.
6. Impeller: Statically and dynamically balanced, [**manufacturer's standard**]<**Insert material**> designed for clear wastewater handling, and keyed and secured to shaft.
7. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at **48-inch- (1200-mm-)** maximum intervals if basin depth is more than **48 inches (1200 mm)**, and grease-lubricated, ball-type thrust bearings.
8. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
9. Pump Discharge Piping: Factory- or field-fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
10. Support Plate: Cast iron or coated steel; strong enough to support pumps, motors, and controls. See "Sump-Pump Basins and Basin Covers" Article for requirements.
11. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
12. Motor: Single speed; grease-lubricated ball bearings and mounting on vertical, cast-iron pedestal.
13. Capacities and Characteristics:

    a. Unit Capacity: <**Insert gpm (L/min.)**>.
    b. Number of Pumps: [**One**][**Two**]<**Insert number**>.
    c. Each Pump:

        1) Capacity: <**Insert gpm (L/min.)**>.
        2) Total Dynamic Head: <**Insert feet (kPa)**>.
        3) Speed: <**Insert rpm**>.
        4) Discharge Size: <**Insert NPS (DN)**>.
        5) Electrical Characteristics:

            a) Motor Horsepower: <**Insert value**> hp.
            b) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
            c) Phases: [**Single**][**Three**].
            d) Hertz: 60.

    d. Unit Electrical Characteristics:

        1) Full-Load Amperes: <**Insert value**> A.
        2) Minimum Circuit Ampacity: <**Insert value**> A.
        3) Maximum Overcurrent Protection: <**Insert value**> A.

14. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

15. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

16. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

2.5 OIL-SENSING SUMP PUMPS AND CONTROLLERS

A. Oil-Sensing Sump Pumps and Controllers: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flo Fab Inc**]
b. [**Industrial Flow Solutions**]
c. [**Liberty Pumps**]
d. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
e. [**Weil Pump; a Wilo Company**]
f. [**Xylem**]
g. [**Zoeller Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Flo Fab Inc**]
b. [**Industrial Flow Solutions**]
c. [**Liberty Pumps**]
d. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
e. [**Weil Pump; a Wilo Company**]
f. [**Xylem**]
g. [**Zoeller Company**]
h. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sump-pump unit. ASME A17.1 compliant.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.

6. Capacities and Characteristic:

    a. Unit Capacity: <**Insert gpm (L/min.)**>.
    b. Number of Pumps: [**One**][**Two**]<**Insert number**>.
    c. Each Pump:

        1) Capacity: <**Insert gpm (L/min.)**>.
        2) Total Dynamic Head: <**Insert feet (kPa)**>.
        3) Speed: <**Insert rpm**>.
        4) Discharge Size: <**Insert NPS (DN)**>.
        5) Electrical Characteristics:

            a) Motor Horsepower: <**Insert value**> hp.
            b) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
            c) Phases: [**Single**][**Three**].
            d) Hertz: 60.

    d. Unit Electrical Characteristics:

        1) Full-Load Amperes: <**Insert value**> A.
        2) Minimum Circuit Ampacity: <**Insert value**> A.
        3) Maximum Overcurrent Protection: <**Insert value**> A.

7. Controls:

    a. Industrial-grade switch(es) with internal [**20**]<**Insert number**> A relay and Type 304 stainless steel sensor probes.
    b. Liquid/oil sensor that differentiates and indicates the presence of oil and/or water under high-water conditions.
    c. Alarm Panel:

        1) High-oil-level alarm.
        2) High-water-level alarm.
        3) Audible and visual alarms for each alarm condition.
        4) Dry contacts for remote monitoring of oil, water, and high liquid conditions.

    d. Control Panel:

        1) [**Simplex**][**Duplex**].
        2) Enclosure: NEMA 250, Type 4X.
        3) HOA switch(es).
        4) Green pump run light; power on light.
        5) Pump circuit breaker(s).

2.6 SUMP PUMPS - PEDESTAL

A. Sump Pumps - Pedestal: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**AMT; a Gorman-Rupp company**]

c. [**Federal Pump Corp**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
f. [**Pentair Aurora; Pentair Pump Group**]
g. [**Tramco Pump Company**]
h. [**Zoeller Company**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**AMT; a Gorman-Rupp company**]
c. [**Federal Pump Corp**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
f. [**Pentair Aurora; Pentair Pump Group**]
g. [**Tramco Pump Company**]
h. [**Zoeller Company**]
i. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, automatic-operation, freestanding, sump-pump unit.
4. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller centrifugal sump pump, configured as a pedestal pump. Sump pump to be as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Corrosion-resistant material, with strainer inlet; design that permits flow into impeller; and vertical discharge for piping connection.
6. Impeller: Aluminum, brass, or plastic.
7. Motor: With built-in overload protection and mounted vertically on sump-pump column.
8. Power Cord: Three-conductor waterproof cable of length required, but not less than **72 inches (1830 mm)**, with grounding plug and cable-sealing assembly for connection at pump.
9. Capacities and Characteristics:

a. Capacity: <**Insert gpm (L/min.)**>.
b. Total Dynamic Head: <**Insert feet (kPa)**>.
c. Speed: <**Insert rpm**>.
d. Discharge Size: <**Insert NPS (DN)**>.
e. Electrical Characteristics:

1) Motor Horsepower: <**Insert value**> hp.
2) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
3) Phases: [**Single**][**Three**].
4) Hertz: 60.

10. Control: Float switch.

2.7 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins : Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: [**Cast iron**][**Fiberglass**][**Polyethylene**]<**Insert material**>.
2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump,

and in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert inches (mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Inlet No. 1:

    a. Drainage Pipe Size: <**Insert NPS (DN)**>.
    b. Bottom of Sump to Centerline: <**Insert inches (mm)**>.
    c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

5. Inlet No. 2:

    a. Drainage Pipe Size: <**Insert NPS (DN)**>.
    b. Bottom of Sump to Centerline: <**Insert inches (mm)**>.
    c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

6. Inlet No. 3:

    a. Drainage Pipe Size: <**Insert NPS (DN)**>.
    b. Bottom of Sump to Centerline: <**Insert inches (mm)**>.
    c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

7. Sidewall Outlet:

    a. Discharge Pipe Size: <**Insert NPS (DN)**>.
    b. Bottom of Sump to Centerline: <**Insert inches (mm)**>.
    c. Type: [**Hubbed inside**][**Hubbed outside**]<**Insert type**>.

8. Cover Material: [**Cast iron**][**Steel with bituminous coating**][**Cast iron or steel with bituminous coating**]<**Insert material**>.
9. Cover Diameter: <**Insert inches (mm)**>, but not less than OD of basin top flange.
10. Manhole Required in Cover: [**Yes**][**No**].
11. Vent Size: <**Insert NPS (DN)**>.

2.8 PACKAGED DRAINAGE-PUMP UNITS - SUBMERSIBLE

A. Packaged Drainage-Pump Units - Submersible: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Liberty Pumps**]

c. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
d. [**Pentair Aurora; Pentair Pump Group**]
e. [**Zoeller Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Liberty Pumps**]
c. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
d. [**Pentair Aurora; Pentair Pump Group**]
e. [**Zoeller Company**]
f. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 14.1-14.2 and HI 14.3.
5. Casing: [**Metal**]<**Insert material**>.
6. Impeller: [**Brass**]<**Insert material**>.
7. Pump Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
9. Power Cord: Three-conductor waterproof cable of length required, but not less than **72 inches (1830 mm)**, with grounding plug and cable-sealing assembly for connection at pump.
10. Pump Discharge Piping: Factory- or field-fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
11. Control: Motor-mounted float switch.
12. Basin: Plastic.
13. Capacities and Characteristics:

a. Capacity: <**Insert gpm (L/min.)**>.
b. Total Dynamic Head: <**Insert feet (kPa)**>.
c. Speed: <**Insert rpm**>.
d. Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Electrical Characteristics:

1) Motor Horsepower: <**Insert value**> hp.
2) Volts: [**115**][**230**][**460**]<**Insert value**> V.
3) Phases: [**Single**][**Three**].
4) Hertz: 60.
5) Full-Load Amperes: <**Insert value**> A.
6) Minimum Circuit Ampacity: <**Insert value**> A.
7) Maximum Overcurrent Protection: <**Insert value**> A.

f. Basin:

1) Capacity: [**2 gal. (7.6 L)**][**5 gal. (18.9 L)**]<**Insert value**> minimum.
2) Inlet Connection: [**NPS 1-1/2 (DN 40)**]<**Insert pipe size**> minimum.

2.9 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps are to be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump-pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 14.4 for installation of sump pumps.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
2. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

C. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. <**Insert startup steps if any**>.

3.6 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain[**controls and**] pumps.

END OF SECTION 22 14 29 00

Task	Specification	Specification Description
22 14 29 00	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 29 13	22 14 29 00	Sump Pumps
22 14 29 13	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 29 16	22 13 29 00	Sanitary Sewerage Pumps
22 14 29 16	22 14 29 00	Sump Pumps
22 14 29 16	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 29 19	22 14 29 00	Sump Pumps
22 14 29 19	22 14 00 00	Facility Storm-Water Retention Tanks

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SECTION 26 01 00 00 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements generally applicable to all electrical Work on the Project, including but not limited to Work specified in Divisions 26, 27, and 28.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> specifies preinstallation conference procedures.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8P8C: An 8-position 8-contact modular jack.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AGC: Automatic gain control.
6. AIC: Ampere interrupting capacity.
7. AL, Al, or ALUM: Aluminum.
8. ASD: Adjustable-speed drive.
9. ATP: Acceptance test procedure.
10. ATS: Automatic transfer switch.
11. A/V: Audio/visual.
12. AWG: American wire gauge; see ASTM B258.
13. BAS: Building automation system.
14. BDA: Bi-directional amplifier.
15. BIL: Basic impulse insulation level.
16. BIM: Building information modeling.
17. BMS: Building management system.
18. BNC: Bayonet Neill-Concelman - type of connector.
19. B/W: Black and white.
20. CAD: Computer-aided design or drafting.
21. CATV: Community antenna television.
22. CB: Circuit breaker.
23. CCD: Charge-coupled device.
24. CCTV: Closed-circuit television.
25. cd: Candela, the SI fundamental unit of luminous intensity.
26. CO/ALR: Copper-aluminum, revised.
27. COPS: Critical operations power system.
28. CU or Cu: Copper.
29. CU-AL or AL-CU: Copper-aluminum.

30. DACR: Digital alarm communicator receiver.
31. DACT: Digital alarm communicator transmitter.
32. DAS: Distributed antenna system.
33. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
34. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
35. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
36. dBm: Decibel absolute power with respect to 1 mW.
37. dBmV: Decibel absolute voltage with respect to 1 mV across identical impedance.
38. DC or dc: Direct current.
39. DCOA: Designated critical operations area.
40. DDC: Direct digital control (HVAC).
41. DGP: Data gathering panel.
42. DHCP: Dynamic host configuration protocol.
43. EGC: Equipment grounding conductor.
44. ELV: Extra-low voltage.
45. EMF: Electromotive force.
46. EMI: Electromagnetic interference.
47. EMP: Electrical maintenance program (operation and maintenance); electromagnetic pulse (transient analysis).
48. EPS: Emergency power supply.
49. EPSS: Emergency power supply system.
50. ERCES: Emergency responder communications enhancement system.
51. ESS: Energy storage system.
52. EV: Electric vehicle.
53. EVPE: Electric vehicle power export equipment.
54. EVSE: Electric vehicle supply equipment.
55. FACU: Fire-alarm control unit.
56. FAS: Fire-alarm system.
57. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
58. FCC: Federal Communications Commission; fire command center.
59. FLC: Full-load current.
60. ft: Foot.
61. ft-cd: Foot-candle, the antiquated U.S. standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" when the SI unit candela (cd) replaced the international candle; see "fc."
62. FTP: File transfer protocol.
63. FXO: Foreign exchange office.
64. GEC: Grounding electrode conductor.
65. GFCI: Ground-fault circuit interrupter.
66. GFPE: Ground-fault protection of equipment.
67. GND: Ground.
68. GROL: General Radiotelephone Operator License (FCC).
69. H.323: Audio and video protocol.
70. HACR: Heating, air conditioning, and refrigeration.
71. HDPE: High-density polyethylene.
72. HID: High-intensity discharge.
73. HP or hp: Horsepower.
74. HVAC: Heating, ventilating, and air conditioning.
75. Hz: Hertz.
76. I&TFAS: Inspection and testing of fire-alarm system.

77. IB-PSC: In-building public safety communications.
78. IBT: Intersystem bonding termination.
79. ICT: Information and communications technology.
80. IDC: Initiating device circuit.
81. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
82. I/O: Input/output.
83. IP: Ingress protection rating (enclosures); Internet protocol (communications).
84. IR: Infrared.
85. IS: Intrinsically safe.
86. IT&R: Inspecting, testing, and repair.
87. ITE: Information technology equipment.
88. kAIC: Kiloampere interrupting capacity.
89. kcmil or MCM: One thousand circular mils.
90. kV: Kilovolt.
91. kVA: Kilovolt-ampere.
92. kvar: Kilovolt-ampere reactive.
93. kW: Kilowatt.
94. kWh: Kilowatt-hour.
95. LAN: Local area network.
96. lb: Pound (weight).
97. lbf: Pound (force).
98. LCD: Liquid-crystal display.
99. LCDI: Leakage-current detector-interrupter.
100. LED: Light-emitting diode.
101. Li-ion: Lithium-ion.
102. lm: Lumen, the SI-derived unit of luminous flux.
103. LNG: Liquefied natural gas.
104. LP-Gas: Liquefied petroleum gas.
105. LRC: Locked-rotor current.
106. LTE: Long-term evolution (mobile device technology standard).
107. LV: Low voltage.
108. lx: Lux, the SI-derived unit of illuminance equal to one lumen per square meter.
109. m: Meter.
110. MATV: Master antenna television.
111. MCC: Motor-control center.
112. MDC: Modular data center.
113. MG set: Motor-generator set.
114. MIDI: Musical instrument digital interface.
115. MLO: Main lugs only.
116. MPEG: Moving Picture Experts Group.
117. MPEG-2: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard for generic coding of moving pictures and associated audio information (ISO/IEC 13818) released in 1995 and used for most over-the-air and satellite broadcast digital television.
118. MPEG-4: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard framework for coding of audio-visual objects (ISO/IEC 14496) released in 1999, with digital rights management and more advanced compression algorithms than MPEG-2.
119. MOV: Metal-oxide varistor.
120. MV: Medium voltage.
121. MVA: Megavolt-ampere.
122. mW: Milliwatt.
123. MW: Megawatt.
124. MWh: Megawatt-hour.
125. NAC: Notification appliance circuit.
126. N.C.: Normally closed.
127. NFC: Near field communications.
128. Ni-Cd: Nickel-cadmium.

129. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.
130. Ni-MH: Nickel-metal hydride.
131. NIU: Network interface unit.
132. N.O.: Normally open.
133. NPT: National (American) standard pipe taper.
134. NTSC: National Television System Committee.
135. OCPD: Overcurrent protective device.
136. ONT: Optical network terminal.
137. PC: Personal computer.
138. PCS: Power conversion system.
139. PCU: Power-conditioning unit.
140. Percent obs/ft (percent obs/m): Percent obscuration per unit distance; unit of measure for sensitivity of smoke detectors.
141. PF or pf: Power factor.
142. PHEV: Plug-in hybrid electric vehicle.
143. PIR: Passive infrared.
144. PLC: Programmable logic controller.
145. PLFA: Power-limited fire alarm.
146. PoE: Power over Ethernet.
147. POTS: Plain old telephone service. See "public switched telephone network" definition.
148. PSTN: Public switched telephone network.
149. PTZ: Pan-tilt-zoom.
150. PV: Photovoltaic.
151. PVC: Polyvinyl chloride.
152. pW: Picowatt.
153. RAID: Redundant array of inexpensive disks; redundant array of independent disks.
154. RAM: Random-access memory.
155. RAT: Radio alarm transmitter.
156. REX: Request-to-exit.
157. RF: Radio frequency.
158. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
159. RMS or rms: Root-mean-square.
160. RPM or rpm: Revolutions per minute.
161. SCADA: Supervisory control and data acquisition.
162. SCCR: Short-circuit current rating.
163. SCR: Silicon-controlled rectifier.
164. SIP: Session initiation protocol.
165. SLC: Signaling-line circuit.
166. SPD: Surge protective device.
167. SPDT: Single pole, double throw.
168. sq.: Square.
169. SWD: Switching duty.
170. TCP/IP: Transmission Control Protocol/Internet Protocol.
171. TEFC: Totally enclosed fan-cooled.
172. TR: Tamper resistant.
173. TVSS: Transient voltage surge suppressor.
174. UHF: Ultra-high frequency.
175. UL: (standards) UL Standards & Engagement Inc.; (product categories) UL, LLC.
176. UL CCN: UL Category Control Number.
177. UPS: Uninterruptible power supply.
178. USB: Universal serial bus.
179. UTC: Coordinated universal time.
180. UV: Ultraviolet.
181. V: Volt, unit of electromotive force.

182. V(ac): Volt, alternating current.
183. V(dc): Volt, direct current.
184. VA: Volt-ampere, unit of complex electrical power.
185. VAR: Volt-ampere reactive, unit of reactive electrical power.
186. VFC: Variable-frequency controller.
187. VOM: Volt-ohm-multimeter.
188. VoIP: Voice over Internet Protocol.
189. VPN: Virtual private network.
190. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
191. VU: Volume unit.
192. W: Watt, unit of real electrical power.
193. WAN: Wide area network.
194. Wh: Watt-hour, unit of electrical energy usage.
195. WPT: Wireless power transfer.
196. WPTE: Wireless power transfer equipment.
197. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERMC: Electrical rigid metal conduit.
10. ERMC-A: Aluminum electrical rigid metal conduit.
11. ERMC-S: Steel electrical rigid metal conduit.
12. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERMC-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.

37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-FPL/FPLR/FPLP: Metal-clad cable containing FPL, FPLR, or FPLP.
31. MC-HL: Metal-clad cable, hazardous location.
32. MI: Mineral-insulated, metal-sheathed cable.
33. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
34. MV: Medium-voltage cable.
35. NM: Nonmetallic sheathed cable.
36. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
37. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
38. NPLF: Non-power-limited fire-alarm circuit cable.
39. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
40. NPLFR: Non-power-limited fire-alarm circuit riser cable.
41. NUCC: Nonmetallic underground HDPE conduit with conductors.
42. OFC: Conductive optical fiber general-purpose cable.

43. OFCG: Conductive optical fiber general-purpose cable.
44. OFCP: Conductive optical fiber plenum cable.
45. OFCR: Conductive optical fiber riser cable.
46. OFN: Nonconductive optical fiber general-purpose cable.
47. OFNG: Nonconductive optical fiber general-purpose cable.
48. OFNP: Nonconductive optical fiber plenum cable.
49. OFNR: Nonconductive optical fiber riser cable.
50. P: Marine shipboard cable.
51. PLTC: Power-limited tray cable.
52. PLTC-ER: Power-limited tray cable, exposed run.
53. PV: Photovoltaic cable.
54. RHH: (high heat) Thermoset rubber, heat-resistant cable.
55. RHW: Thermoset rubber, moisture-resistant cable.
56. SA: Silicone rubber cable.
57. SE: Service-entrance cable.
58. SER: Service-entrance cable, round.
59. SEU: Service-entrance cable, flat.
60. SIS: Thermoset cable for switchboard and switchgear wiring.
61. TBS: Thermoplastic cable with outer braid.
62. TC: Tray cable.
63. TC-ER: Tray cable, exposed run.
64. TC-ER-HL: Tray cable, exposed run, hazardous location.
65. THW: Thermoplastic, heat- and moisture-resistant cable.
66. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
67. THHW: Thermoplastic, heat- and moisture-resistant cable.
68. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
69. TW: Thermoplastic, moisture-resistant cable.
70. UF: Underground feeder and branch-circuit cable.
71. USE: Underground service-entrance cable.
72. XHH: Cross-linked polyethylene, heat-resistant cable.
73. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations and Acronyms for Electrical Flexible Cord Types:

1. SEO: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
3. SEOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
4. SEOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
6. SJEOW: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
7. SJEOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
8. SJEOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
11. SJOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.

12. SJOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
15. SJTOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
16. SJTOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.
18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
19. SOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.
20. SOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.
23. STOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
24. STOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E. Abbreviations for Communications Spaces:

1. EF: Entrance facility; generally serves campus or building. EF may include an ER.
2. ER: Equipment room; generally serves campus or building.
3. TE: Telecommunications enclosure; generally serves a single tenant or floor.
4. TR: Telecommunications room; generally serves a single tenant or floor.

F. Abbreviations for Communications Facilities:

1. HC: Horizontal cross-connect; also called "floor distributor" (FD).
2. IC: Intermediate cross-connect; also called "building distributor" (BD).
3. MC: Main cross-connect; also called "campus distributor" (CD).

G. Abbreviations for Grounding and Bonding:

1. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
2. PBB: Primary bonding busbar; located in main distribution frame room, ideally near electrical service entrance.
3. RBB: Rack bonding busbar; located in equipment cabinets and racks.
4. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
5. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
6. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
7. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
8. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

H. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."

    a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.

2. Agile Receiver: A broadband receiver that can be tuned to any desired channel.
3. Backbone: Primary segment of ERCES between donor antenna and distribution cabling.
4. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
5. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.
6. Broadcast Media: Loudspeakers, radios, cellular phones, and other media that will carry the selected message to the selected audience.
7. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
8. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, the signal is spread out over a wider band. The carrier frequency is the center frequency on any television channel.
9. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
10. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
11. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
12. Conductive Cable: Cable containing non-current-carrying electrically conductive members such as metallic strength members and metallic vapor barriers.
13. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
14. Conduit: A structure containing one or more duct raceways.
15. Control Unit: A system component that monitors inputs and controls outputs through various types of circuits.

    a. Autonomous Control Unit (ACU): The primary control unit for an in-building mass notification system (MNS).
    b. Emergency Communications Control Unit (ECCU): A system capable of sending mass notification messages to individual buildings, zones of buildings, individual outdoor loudspeaker arrays, or zones of outdoor loudspeaker arrays; or a building, multiple buildings, outside areas, or a combination of these.
    c. Fire-alarm control unit (FACU).
    d. Wireless Control Unit: A component that transmits/receives and processes wireless signals.

16. Designated Seismic System: An architectural, electrical, or mechanical system and its components for which the component importance factor is greater than 1.0 when determined in

accordance with Section 018123 "Facility Seismic and Wind Criteria."

17. Direct Buried: Installed underground without encasement in concrete or other protective material.
18. Downlink: The signal from a base station to portable radios.
19. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
20. Duct Raceway: A single enclosed raceway for conductors or cable.
21. Electrical Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
22. Emergency Communications System (ECS): A system for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action.

    a. Distributed Recipient Mass Notification System (DRMNS): A system meant to communicate directly to targeted individuals and groups that might not be in a contiguous area.
    b. Emergency Voice/Alarm Communications System (EVACS): Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as evacuation signals pertaining to an emergency, to the occupants of a building.
    c. Mass Notification System (MNS): A system used to provide information and instructions to people in buildings or other spaces using intelligible voice communications and including visual signals, text, graphics, tactile, or other communication methods (in-building MNS); and could have the capability to provide real-time information to outdoor areas and to communicate with other notification systems provided for a campus, region, or global geographic setting (wide-area MNS).

23. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that is designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety of human life.
24. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Concrete Box: A box intended for use in poured concrete.
    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
    d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
    e. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
    f. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
    g. Device Box: A box with provisions for mounting a wiring device directly to the box.
    h. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
    i. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
    j. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
    k. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the

entrance of scrub water at the floor level.

l. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
m. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
n. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
o. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
p. Raised-Floor Box: A floor box intended for use in raised floors.
q. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
r. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
s. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
t. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

25. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
26. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.

    a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.

27. Headend: The control center of the MATV system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "central retransmission facility."
28. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
29. High Power Loudspeaker Array (HPLA): A product providing capability for voice and tone communication to large outdoor areas.
30. Jack: Also commonly called an "outlet," it is the fixed, female connector.
31. Jacket: A continuous nonmetallic outer covering for conductors or cables.
32. Local Operator Console (LOC): Equipment used by authorized personnel and emergency responders to activate and operate a mass notification system (MNS).
33. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
34. Master Control Unit: System component that accepts inputs from other control units and may also

perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

35. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
36. Monitoring: Acquisition, processing, communication, and display of system and equipment status data and event and alarm signals.
37. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
38. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
39. Nonsecure: Unlocked or open. (For doors and gates.)
40. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. Also called "single-line diagram."
41. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
42. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
43. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
44. Protective Device: A device that senses when an abnormal current flow, abnormal voltage potential, or other abnormal electrical waveform exists and then disconnects the affected portion of the circuit from the system. Common protective devices include fuses, circuit breakers, relays, ground-fault circuit interrupters, and arc-fault circuit interrupters.
45. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted pair cables from a telephone-provider central office for the transmission medium. "PSTN" refers to the telephone network; "POTS" refers to the individual subscriber line.
46. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
47. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
48. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
49. Secure: Closed and locked and with no unlock or open commands pending. (For doors and gates.)
50. Sheath: A continuous metallic covering for conductors or cables.
51. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
52. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
53. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
54. Uplink: The signal from a portable radio to the base station.
55. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.
56. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
    b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
    c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
    d. Low Voltage (LV): Having electromotive force between any two conductors, or between a

single conductor and ground, that is rated above 30 V but not exceeding 1000 V.

e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.

f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

57. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

58. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.
3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:

    a. Exercising generators.
    b. Emergency lighting.
    c. Elevators.
    d. Fire-alarm systems.

4. Arrange to provide temporary emergency and standby electrical [**service**][**or**][**power**] so facility may remain occupied during the outage in accordance with requirements specified in Section 015000 "Temporary Facilities and Controls." Coordinate power requirements with Owner.

B. Interruption of Existing Telephone Service: Do not interrupt telephone service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of telephone service.
2. Do not proceed with interruption of telephone service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

C. Interruption of Existing Internet Service: Do not interrupt internet service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of internet service.
2. Do not proceed with interruption of internet service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

D. Interruption of Existing Security System: Do not interrupt security system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of security system.
2. Do not proceed with interruption of security system without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

E. Interruption of Existing Fire-Alarm System: Do not interrupt fire-alarm system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of fire-alarm system.
2. Do not proceed with interruption of fire-alarm system without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

1.4 PREINSTALLATION MEETINGS

A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Electrical installation schedule.
2. Status of power system studies.
3. Value analysis proposals and requests for substitution of electrical equipment.
4. Utility work coordination and class of service requests.
5. Commissioning activities.
6. Sustainability activities[**, including Measurement and Verification Plan**].

B. Communications Preconstruction Conference: Schedule conference with Architect and Owner not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Installation schedule for communications systems.
2. Value analysis proposals and requests for substitution of communications equipment.
3. Utility services work coordination and monitoring service requests.
4. Commissioning activities.
5. Sustainability activities.

C. Electronic Safety and Security Preconstruction Conference: Schedule conference with Architect and Owner not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Installation schedule for security, fire-alarm, and other life-safety systems.
2. Value analysis proposals and requests for substitution of electronic safety and security equipment.
3. Monitoring services work coordination and monitoring service requests.
4. Commissioning activities.
5. Sustainability activities.

1.5 SEQUENCING

A. Conduct and submit results of power system studies before submitting product data and Shop Drawings

for electrical equipment.

1.6 SCHEDULING

A. <**Insert requirements for unusual scheduling coordination**>.

1.7 ACTION SUBMITTALS

A. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.

B. Coordination Drawings for Ceiling Areas: Where indicated on drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment and suspension systems will be attached.
3. Size and location of access panels on ceilings.
4. Elevation, size, and route of sprinkler piping.
5. Elevation, size, and route of plumbing piping.
6. Elevation, size, and route of ductwork.
7. Elevation, size, and route of cable tray.
8. Elevation, size, and route of conduit.
9. Elevation and size of wall-mounted and ceiling-mounted equipment.
10. Access panels.
11. Sprinklers.
12. Air inlets and outlets.
13. Control modules.
14. Luminaires.
15. Communications devices.
16. Speakers.
17. Security devices.
18. Fire-alarm devices.
19. Indicate clear dimensions for maintenance access in front of equipment.
20. Indicate dimensions of fully open access doors.

C. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Elevation, size, and route of cable trays.
2. Relationships between components and adjacent structural, electrical, and mechanical elements.
3. Vertical and horizontal offsets and transitions.
4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
5. Elevation of ceilings and size of ceiling tiles.
6. Locations of access panels on ceilings.
7. Locations where cable tray crosses or parallels sprinkler piping.
8. Locations where cable tray crosses plumbing piping.
9. Locations where cable tray crosses or parallels ductwork.
10. Locations of access panels on ductwork.
11. Locations where cable tray crosses conduit.

12. Items blocking access around cable trays, including the following:

    a. Light fixtures.
    b. Speakers.
    c. Fire-alarm devices.
    d. Power outlets.
    e. Wall-mounted equipment.
    f. Equipment racks.
    g. Furniture.
    h. Door swings.
    i. Building features.

13. Indicate clear dimension between cable tray and walls or obstructions that are closer than **10 ft (3 m)**.
14. Highlight locations where cable tray is greater than **3 ft (1 m)** above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.

D. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

E. Coordination Drawings for Bus Assembly Routing: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements.
2. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
3. Clearances for access above and to the side of enclosed bus assemblies.
4. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
5. Support locations, type of support, and weight on each support.
6. Location of adjacent construction elements, including luminaires, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

F. Coordination Drawings for Large Equipment Indoor Installations:

1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

    a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
    b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
    c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.

3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways**[, busways,]**[**and seismic bracing**].
b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.

G. Coordination Drawings for Large Equipment Outdoor Installations:

1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
b. Indicate clear dimensions for fence gates and wall openings.
c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways**[, busways,]**[**and seismic bracing**].
f. Dimensioned working clearances and dedicated areas around electrical equipment.

H. Coordination Drawings for Duct Banks:

1. Show duct profiles and coordination with other utilities and underground structures.
2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

I. Sustainable Design Submittals:

1. Electrical Waste Management (Wire): Provide documentation for quantity of abandoned electrical wire that has been removed from Project site, in accordance with Rule 645.5(G) of NFPA 70, and provide verification that abandoned wire containing lead stabilizers has been identified and disposed of in accordance with jurisdictional hazardous waste requirements.
2. Electrical Waste Management (Lamps): Provide documentation that an area has been provided to serve entire Project for collection and storage of fluorescent and HID lamps and ballasts for their appropriate disposal or recycling in accordance with jurisdictional hazardous waste requirements.
3. Electrical Waste Management (Electronics and Batteries): Provide documentation that an area has been provided to serve entire Project for collection and storage of electronics, alkaline batteries, and rechargeable batteries for their appropriate disposal or recycling in accordance with jurisdictional hazardous waste requirements.

1.8 INFORMATIONAL SUBMITTALS

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 26.
4. Orders placed for major electrical equipment.

5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Utility service outages.
8. Utility service inspection and activation.
9. Mockup reviews.
10. Closing of walls and ceilings containing electrical Work.
11. System startup, testing, and commissioning activities for major electrical equipment.
12. System startup, testing, and commissioning activities for emergency lighting.
13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

B. Installation Schedule for Communications Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of the communications Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 27.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 27.
6. Telephone and internet service outages.
7. Telephone and internet service inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the communications Work.
10. System startup, testing, and commissioning activities for communications equipment.
11. System startup, testing, and commissioning activities for the Work specified in other divisions that depends on the Work specified in Division 27.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.
14. Requests for inspections by authorities having jurisdiction.

C. Installation Schedule for Security, Fire-Alarm, and Other Life-Safety Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of security, fire-alarm, and the other life-safety Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 28.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 28.
6. Security and fire-alarm system outages.
7. Security and fire-alarm system inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the security and fire-alarm Work.
10. System startup, testing, and commissioning activities for security and fire-alarm equipment.
11. System startup, testing, and commissioning activities for fire-alarm interfaces with the Work specified in other divisions.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.

14. Requests for inspections by authorities having jurisdiction.

D. Welding certificates.

E. Seismic Performance Certificates: Provide special certification for designated seismic systems as required to meet requirements specified in Section 018123 "Facility Seismic and Wind Criteria" for all designated seismic systems identified on the Drawings or in the Specifications.

1. Include the following information:

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
d. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
e. Equipment manufacturer's written certification for each designated active electrical seismic device and system, stating that it will remain operable following the basis-of-design seismic criteria specified in Section 018123 "Facility Seismic and Wind Criteria."
f. Equipment manufacturer's written certification that components with hazardous contents maintain containment following the basis-of-design seismic criteria specified in Section 018123 "Facility Seismic and Wind Criteria."
g. Evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by qualified structural professional engineer.

F. Wind Performance Certificates: Provide special certification for systems and components designated on the Drawings or in the Specifications to be subject to high wind exposure and impact damage.

1. Include the following information:

a. Provide equipment manufacturer's written certification for each designated system and component, stating that it will remain in place and operable following the design wind event and comply with requirements of authorities having jurisdiction.
b. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

G. Qualification Statements:

1. For qualified regional manufacturer.
2. For structural professional engineer.
3. For electrical professional engineer.
4. For lighting professional engineer.
5. For EPM specialist.
6. For welder.
7. For ERMC-S-PVC raceway Installer.
8. For medium-voltage cable Installer.
9. For medium-voltage duct Installer.
10. For medium-voltage equipment Installer.
11. For electrical power monitoring Installer.
12. For switchboard Installer.
13. For EVSE Installer.
14. For generator set Installer.
15. For lightning protection system Installer.

16. For theatrical lighting Installer.
17. For exterior athletic lighting Installer.
18. For power quality specialist.
19. For electrical testing and inspecting agency and its on-site electrical testing supervisor.
20. For structural testing and inspecting agency.
21. For outdoor pole testing and inspecting agency.
22. For luminaire photometric testing laboratory.
23. For lighting testing and inspecting agency.
24. For communications design professional.
25. For communications cable Installer.
26. For communications testing and inspecting agency and its on-site communications testing supervisor.
27. For nurse call/code blue system Installer.
28. For security design professional.
29. For fire-alarm system design professional.
30. For mass notification design professional.
31. For IB-PSC design professional.
32. For general radiotelephone operator license (GROL) designer.
33. For emergency communications design professional.
34. For fire-alarm cable Installer and its on-site fire-alarm cable installation supervisor.
35. For security testing and inspecting agency and its on-site security testing supervisor.
36. For intrusion detection systems installer.
37. For perimeter security systems integrator.
38. For fire-alarm testing agency and its on-site fire-alarm testing supervisor.
39. For detention electronics systems Installer.
40. For detention electronics systems integrator.
41. For detention electronics systems testing and inspecting agency.

1.9 CLOSEOUT SUBMITTALS

A. Facility EMP Binders:

1. Complete Set: On [**approved online or cloud solution**][**and**][**USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement**].
2. Volumes 2 and 8: Reproducible hardcopy on archival quality, **28 lb (105 GSM)**, acid-free, bond paper.

B. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:

   a. <**Insert system, equipment, or device**>.

2. Include the following information:

   a. Manufacturer's operating specifications.
   b. User's guides for software and hardware.
   c. Schedule of maintenance material items recommended to be stored at the Project site.
   d. Detailed instructions covering operation under both normal and abnormal conditions.
   e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
   f. List of load-current and overload-relay heaters with related motor nameplate data.
   g. List of lamp types and photoelectric relays used on the Project, with ANSI and

manufacturers' codes.
h. Manufacturer's instructions for setting field-adjustable components.
i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
k. Exterior pole inspection and repair procedures.

C. Software and Firmware Operational Documentation: Provide software and firmware operational documentation[**in Facility EPM Binders**], including the following:

1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.
6. For lighting controls, include the following:

a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
b. Operation of adjustable zone controls.

D. Software:

1. Program Software Backup: Provide [**username and password for approved online or cloud solution**][**and**][**USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement**].
2. Provide to Owner upgrades and unrestricted licenses[**for Government use**] for installed and backup software, including operating systems and programming tools required for operation and maintenance.

1.10 MOCKUPS

A. Simple Mockups for Coordinating Accessibility of Electrical Devices around Fixed Furnishings and Equipment:

1. Build simple mockups using art supplies and other inexpensive materials for verification of general arrangement, actual dimensions, and accessibility of <**Insert identification of room and fabrication**> by [**Architect**][**Owner**][**Tenant**]<**Insert approving stakeholders**> prior to fabrication and installation of Work. Depict products from all Divisions requiring coordination, including, but not limited to, fixed furnishings, casework, outlet covers and plates, HVAC controls, exposed raceway, exposed plumbing, equipment, and signage.

B. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the

Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

2.2 SUBSTITUTION LIMITATIONS FOR COMMUNICATIONS EQUIPMENT

A. Substitution requests for communications equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Communications Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Communications Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

2.3 SUBSTITUTION LIMITATIONS FOR ELECTRONIC SAFETY AND SECURITY EQUIPMENT

A. Substitution requests for electronic safety and security equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electronic Safety and Security Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Electronic Safety and Security Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

2.4 FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP) BINDERS

A. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EMP development.

B. Applicable Standards:

1. Regulatory Requirements: Comply with requirements in NFPA 70B.
2. General Characteristics:

a. Volume 1 - Introduction:

1) Summarize how Facility EMP analysis was performed, how data were collected, and how volumes are organized.
2) Describe Facility EMP and provide recommended policies and procedures for implementing the program and keeping it current.
3) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EMP.

b. Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:

1) Include training requirements for employees and contractors.
2) Include list of known facility hazards impacting IT&R activities.
3) Include approval and permitting procedures for IT&R activities.
4) Include incident emergency response procedures.
5) Include emergency shutdown procedures.
6) Include electrical disaster recovery procedures.
7) Include procedures for investigating the following incidents:

a) Electrical safety incidents.
b) Equipment malfunctions.
c) Unintended operations or alarms.
d) Operation of protective devices.

c. Volume 3 - Operating Procedures for Electrical Equipment and Controls:

1) <**Insert requirements**>.

d. Volume 4 - Facility Diagrams and Schedules:

1) Include single-line diagrams.
2) Include grounding and bonding diagrams.
3) Include essential wiring diagrams.
4) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
5) Include records of switchgear, switchboard, and panelboard schedules.
6) Include time-current curves for overcurrent protective devices.
7) Include list of load-current and overload-relay heaters with related motor nameplate data.

e. Volume 5 - Inventory of Facility Equipment Using Electrical Power:

1) Include simplified floor plans showing equipment locations.
2) Identify critical equipment (electrical or otherwise).
3) Include identifying designations and nameplate data.
4) Include warranty and maintenance contract information.

f. Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:

1) Include schedules of maintenance material items recommended to be stored at facility.
2) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
3) Include calibration and servicing data for each item.

g. Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:

1) Include tables showing frequency of activities for each item.
2) Include annual schedule with activities mapped to specific days of the year.
3) Include exterior pole inspection and repair procedures.

h. Volume 8 - Inspection, Testing, and Repair (IT&R) Forms:

1) <**Insert requirements**>.

i. Volume 9 - Inspection, Testing, and Repair (IT&R) Procedures:

1) <**Insert requirements**>.

j. Volume 10 - Spare Parts List:

1) Include list of all parts required to perform IT&R procedures.
2) Identify quantities of which parts are recommended to be stored on-site.
3) Include source contact information and budget cost for each item.

k. Volume 11 - Construction Project Closeout Record Documentation:

1) Include records of power system studies and photometric studies.
2) Include records of risk assessment studies.
3) Include records of electrical system startup and commissioning activities.
4) Include records of baseline inspections and tests.
5) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.
6) Include records of baseline settings for adjustable equipment and devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. <**Insert Project requirements**>.

B. Preinstallation Testing:

1. <**Insert Project requirements**>.

C. Evaluation and Assessment:

1. <**Insert Project requirements**>.

3.2 PREPARATION

A. Protection of In-Place Conditions:

1. <**Insert Project requirements**>.

3.3 DEVELOPMENT OF FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP)

A. Facility EMP must be developed by qualified EMP specialist.

B. Conduct Facility EMP analysis in accordance with NFPA 70B requirements.

1. Renovation Projects:

a. Facility diagrams must include connected existing equipment for entire facility where

known. Areas of uncertainty should be clearly indicated.

b. Obtain copies of existing operation and maintenance data and existing Facility EMP information from Owner.

c. Facility EMP analysis should identify existing equipment that does not have available operation and maintenance data, and should explain Owner's risks because this equipment is not included in Facility EMP.

d. Data for existing equipment outside scope of the Project may be inserted in Facility EMP Binders without analysis.

e. Data for existing equipment impacted by scope of the Project should be analyzed and documented similar to the Project's new equipment data as much as possible.

C. Compile operation and maintenance data from Facility EMP analysis and submit [**updated**] Facility EMP Binders.

3.4 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of electrical Work on the Project. Consult Architect for resolution of conflicting requirements.

3.5 CLEANING

A. Electrical or Electronic Waste Management:

1. <**Insert requirements for special handling or diversion of electrical and electronics waste for recycling or disposal**>.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

   a. How to implement [**updated**] Facility EMP.
   b. <**Insert system or equipment**>.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

END OF SECTION 26 01 00 00

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Task	Specification	Specification Description
26 01 10 00	26 01 00 00	Supplemental Requirements for Electrical
26 01 10 91	26 01 00 00	Supplemental Requirements for Electrical
26 01 20 00	26 01 00 00	Supplemental Requirements for Electrical
26 01 20 91	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 00	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 51	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 51	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 52	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 52	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 53	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 53	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 81	26 01 00 00	Supplemental Requirements for Electrical

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SECTION 26 05 00 00 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Sealants.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
3. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of raceways, electrical power cabling, and communications cabling referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 270528 "Pathways for Communications Systems" [**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Advance Products & Systems, LLC**]
    b. [**CCI Piping Systems**]
    c. [**Flexicraft Industries**]
    d. [**GPT Industries, LLC.**]
    e. [**Specified Technologies Inc.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advance Products & Systems, LLC**]
    b. [**CCI Piping Systems**]
    c. [**Flexicraft Industries**]
    d. [**GPT Industries, LLC.**]
    e. [**Specified Technologies Inc.**]
    f. <**Insert manufacturer's name**>

3. Standard Features:

    a. Referenced Standard: ASTM A53/A53M, Type E, Grade B.
    b. Dimensions: Schedule 40; sized so outer diameter of sleeve matches inner diameter of penetration hole.
    c. Corrosion Resistance: Coated with [**Zinc**][**or**][**Gal-vo-plast**] .
    d. Configuration: Plain ends and integral waterstop.

B. Cast-Iron Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**American Cast Iron Pipe Company**]
    b. [**Flexicraft Industries**]
    c. [**McWane Ductile; a part of the McWane family of companies**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Cast Iron Pipe Company**]
    b. [**Flexicraft Industries**]
    c. [**McWane Ductile; a part of the McWane family of companies**]
    d. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe.
b. Configuration: Plain ends and integral waterstop.

C. PVC Pipe Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CCI Piping Systems**]
b. [**GPT Industries, LLC.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CCI Piping Systems**]
b. [**GPT Industries, LLC.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Referenced Standard: ASTM D1785.
b. Dimensions: Schedule 40.

D. PVC Molded Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**American Polywater Corporation**]
c. [**Arlington Industries, Inc.**]
d. [**Reliance Worldwide Corporation**]
e. [**Roxtec Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**American Polywater Corporation**]
c. [**Arlington Industries, Inc.**]
d. [**Reliance Worldwide Corporation**]
e. [**Roxtec Inc.**]
f. <**Insert manufacturer's name**>

3. Standard Features: With nailing flange for attaching to wooden forms.

E. PE or PP Molded Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Polywater Corporation**]
   b. [**Crete-Sleeve**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Polywater Corporation**]
   b. [**Crete-Sleeve**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Round, Galvanized-Steel, Sheet Metal Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Benefast**]
   b. [**Specified Technologies Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Benefast**]
   b. [**Specified Technologies Inc.**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Galvanized-steel sheet; thickness not less than **0.0239 inch (0.6 mm)**; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Abesco Fire LLC**]
b. [**Specified Technologies Inc.**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Abesco Fire LLC**]
b. [**Specified Technologies Inc.**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Material: Galvanized sheet steel.
b. Minimum Metal Thickness:

1) For sleeve cross-section rectangle perimeter less than **50 inch (1270 mm)** and with no side larger than **16 inch (400 mm)**, thickness must be **0.052 inch (1.3 mm)**.
2) For sleeve cross-section rectangle perimeter not less than **50 inch (1270 mm)** or with one or more sides larger than **16 inch (400 mm)**, thickness must be **0.138 inch (3.5 mm)**.

2.3 SLEEVE-SEAL SYSTEMS

A. Sleeve-Seal System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advance Products & Systems, LLC**]
b. [**American Polywater Corporation**]
c. [**BWM Company**]
d. [**CALPICO, Inc.**]
e. [**Flexicraft Industries**]
f. [**GPT Industries, LLC.**]
g. [**Metraflex Company (The)**]
h. [**Proco Products, Inc**]
i. [**Roxtec Inc.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**American Polywater Corporation**]
c. [**BWM Company**]
d. [**CALPICO, Inc.**]
e. [**Flexicraft Industries**]

f. [**GPT Industries, LLC.**]
g. [**Metraflex Company (The)**]
h. [**Proco Products, Inc**]
i. [**Roxtec Inc.**]
j. <**Insert manufacturer's name**>

3. Standard Features:

a. Modular Sealing Device: Designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
b. Sealing Elements: [**EPDM**][**Nitrile (Buna N)**] rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
c. Pressure Plates: [**Carbon steel**][**Fiber-reinforced plastic**][**Stainless steel**] .
d. Connecting Bolts and Nuts: [**Carbon steel, with corrosion-resistant coating,**][**Stainless steel,**] of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Sleeve-Seal Fitting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Holdrite; a division of Reliance Worldwide Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Holdrite; a division of Reliance Worldwide Corporation**]
b. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall.
b. Waterstop Collar: Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Grout for Sealing Penetrations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Specified Technologies Inc.**]
b. [**W. R. Meadows, Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Specified Technologies Inc.**]
b. [**W. R. Meadows, Inc**]
c. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Nonshrinking grout; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
b. Referenced Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
c. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
d. Packaging: Premixed and factory packaged.

2.6 SEALANTS

A. Pourable Sealants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carlisle SynTec Systems; a Carlisle Company**]
b. [**GAF**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Specified Technologies Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Carlisle SynTec Systems; a Carlisle Company**]
b. [**GAF**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Specified Technologies Inc.**]
e. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
b. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

4. Sustainability Characteristics:

    a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.

B. Foam Sealants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Innovative Chemical Products (Building Solutions Group)**]
    b. [**The Dow Chemical Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Innovative Chemical Products (Building Solutions Group)**]
    b. [**The Dow Chemical Company**]
    c. <**Insert manufacturer's name**>

3. Standard Features:

    a. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
    b. Foam Expansion: Must not damage cables or crack penetrated structure.

4. Sustainability Characteristics:

    a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Communications Work: BICSI N1.

8. Work in ITE Rooms: NFPA 75.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies: Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Interfaces with Other Work:

1. Identification: Provide labels for penetrations and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Grounding and Bonding:

a. Bonding of Metal Sleeve for Metal Raceway Penetrations: Bond metal raceway to metal sleeve on both sides of penetration.
b. Bonding of Metal Sleeve for Cable Penetrations: Bond equipment grounding conductor for electrical power cables, or cable shield for communications cables, to metal sleeve on both sides of penetration.
c. Bonding is not required for nonmetallic sleeves.
d. Grounding of communications cables entering buildings from outside must be provided at the penetration.

3. Hangers and Supports:

a. Support of Raceways and Cables in Sleeve: Comply with manufacturer's published instructions for supporting raceways or cables on both sides of penetration. Sleeve sealing products are typically not rated for supporting the weight of raceways and cables.

3.2 INSTALLATION OF ROUND SLEEVES

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide [**1/4 inch (6.4 mm)**]<**Insert dimension**> annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed [**or seismic criteria require different clearance**] .

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors [**2 inch (50 mm)**]<**Insert dimension**> above finished floor level. Install sleeves during erection of floors.
6. Seal space outside of sleeves with approved joint compound for wall assemblies.

B. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

C. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [**steel**][**cast-iron**] pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for **1 inch (25 mm)** annular clear space between pipe and sleeve for installing mechanical sleeve seals.

D. Underground, Exterior-Wall and Floor Penetrations:

1. Install [**steel**][**cast-iron**] pipe sleeves with integral waterstops. Size sleeves to allow for **1 inch (25 mm)** annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for **1 inch (25 mm)** annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.3 INSTALLATION OF RECTANGULAR SLEEVES

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 26 05 00 00

SECTION 26 05 13 00 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cables.
2. Connectors.
3. Solid terminations.
4. Separable insulated connectors.
5. Splice kits.
6. Medium-voltage tapes.
7. Arc-proofing materials.
8. Fault indicators.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

B. Samples: **16 inch (400 mm)** lengths for each type of cable specified.

C. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For solvents and adhesives, indicating VOC content.
3. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate location of each cable, splice, and termination.

B. Material Certificates: For each type of cable and accessory.

C. Design Data: Cable pulling calculations, including conduit size and fill percentage, pulling tensions, cable sidewall pressure, jam probability, voltage drop, and ground wire sizing for each cable.

D. Source quality-control reports.

E. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**General Cable; Prysmian Group North America**]
2. [**Hendrix Wire and Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
3. [**Kerite Power Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
4. [**Okonite Company (The)**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Southwire Company, LLC**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**General Cable; Prysmian Group North America**]
2. [**Hendrix Wire and Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
3. [**Kerite Power Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
4. [**Okonite Company (The)**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Southwire Company, LLC**]
7. <**Insert manufacturer's name**>

C. Cable Type: [**Type MV 90**][**Type MV 105**].

D. Conductor Insulation: [**Crosslinked polyethylene**][**Ethylene-propylene rubber**].

1. Voltage Rating: [**5**][**8**][**15**][**25**][**35**] kV.
2. Insulation Thickness: [**100**][**133**] percent insulation level.

E. Conductor: [**Copper**][**Aluminum**].

F. Comply with UL 1072, AEIC CS8[**, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682**][**, and ICEA S-94-649**].

G. Conductor Stranding: [**Compact round, concentric lay, Class B**][**Concentric lay, Class B**].

H. Strand Filling: Conductor interstices are filled with impermeable compound.

I. Lead Content: Less than 300 parts per million.

J. Shielding: [**Copper tape**][**Solid copper wires**], helically applied over semiconducting insulation shield.

K. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

L. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together[**with ground conductors**].

1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

M. Cable Sheath: [**Interlocked aluminum**][**Interlocked galvanized steel**][**Corrugated aluminum tube**] applied over cable.

N. Cable Jacket: [**Sunlight-resistant PVC**][**Chlorosulfonated polyethylene**].

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**G&W Electric Company**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**G&W Electric Company**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

D. Copper-Conductor Connectors: [**Copper barrel crimped**][**Aluminum barrel crimped**][**Copper shear bolt**] connectors.

2.4 SOLID TERMINATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**G&W Electric Company**]
5. [**Shawflex; Shawcor Ltd.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**G&W Electric Company**]
5. [**Shawflex; Shawcor Ltd.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal-body, metal-clad cable terminator for metal-clad cable [**with**][**without**] external plastic jacket.
2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
3. Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
4. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.

D. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations:

    a. Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.
    b. Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
    c. Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
    d. Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

2. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape; cold-shrink-rubber sleeve; or heat-shrink, plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
3. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Richards Manufacturing Co.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Richards Manufacturing Co.**]
4. <**Insert manufacturer's name**>

D. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

E. Load-Break Cable Terminators: Elbow-type units with 200 A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

F. Dead-Break Cable Terminators: Elbow-type unit with [**200 A**][**600 A**] continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

G. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

H. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

I. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 SPLICE KITS

A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**Richards Manufacturing Co.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**Richards Manufacturing Co.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

D. Standard: Comply with IEEE 404.

E. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink-rubber, in-line splicing kit.
4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
5. Separable multiway splice system with all components for the required splice configuration.

2.7 MEDIUM-VOLTAGE TAPES

A. Description: Electrical grade, insulating tape rated for medium voltage application.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**HellermannTyton**]
3. [**Scapa Industrial; Scapa Group plc**]

4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**HellermannTyton**]
3. [**Scapa Industrial; Scapa Group plc**]
4. <**Insert manufacturer's name**>

D. Ethylene/propylene rubber-based, **30 mil (0.76 mm)** splicing tape, rated for 130 deg C operation. Minimum **3/4 inch (20 mm)** wide.

E. Silicone rubber-based, **12 mil (0.30 mm)** self-fusing tape, rated for 130 deg C operation. Minimum **1-1/2 inch (38 mm)** wide.

F. Insulating-putty, **125 mil (3.175 mm)** elastic filler tape. Minimum **1-1/2 inch (38 mm)** wide.

2.8 ARC-PROOFING MATERIALS

A. Description: Fire retardant, providing arc flash protection.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. <**Insert manufacturer's name**>

D. Tape for First Course on Metal Objects: **10 mil (250 micrometer)** thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

E. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to **0.3 inch (8 mm)** thick, and compatible with cable jacket.

F. Glass-Cloth Tape: Pressure-sensitive adhesive type, **1 inch (25 mm)** wide.

2.9 FAULT INDICATORS

A. Indicators: [**Automatically**][**Manually**] reset fault indicator[**with inrush restraint feature**], arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.10 SOURCE QUALITY CONTROL

A. Test and inspect cables according to [**ICEA S-97-682**][**ICEA S-94-649**] before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of **5 psig (35 kPa)**.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by **48 to 72 inch (1200 to 1800 mm)** on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

F. Install direct-buried cables on leveled and tamped bed of **3 inch (75 mm)** thick, clean sand. Separate cables crossing other cables or piping by a minimum of **2 inch (50 mm)** of tamped earth, plus an additional **2 inch (50 mm)** of sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

G. Install "buried-cable" warning tape **12 inch (305 mm)** above cables.

H. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

I. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

J. Install cable splices at pull points and elsewhere as indicated; use standard kits.[**Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.**]

K. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

L. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

M. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with **10 mil (250 micrometer)** pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with two layers of **1 inch (25 mm)** wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

N. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."

O. Install fault indicators on each phase where indicated.

P. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

Q. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

R. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 05 13 00

Task	Specification	Specification Description
26 05 13 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 13 16	26 05 13 00	Medium-Voltage Cables
26 05 13 16	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 13 16	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 19 00 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-insulated wire.
2. Thermoset-insulated wire.
3. Nonmetallic underground conduit with conductors.
4. Metallic sheathed cable.
5. Photovoltaic single-conductor cable.
6. Nonmetallic jacketed cable.
7. Connectors and splices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.
6. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260533.13 "Conduits for Electrical Systems" specifies installation of raceways referenced by this Section.
10. Section 260536 "Cable Trays for Electrical Systems" specifies cable tray installation referenced by this Section.
11. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling" specifies installation of sleeves and sleeve seals referenced by this Section.
12. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
13. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
14. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.2 DEFINITIONS

A. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

1.3 ACTION SUBMITTALS

A. Product Schedule: Indicate type, use, location, and termination locations.

B. Product Data: For each type of product.

C. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
3. Product Data: For solvents and adhesives, indicating VOC content.
4. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Field reports for infrared scanning.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 THERMOPLASTIC-INSULATED WIRE

A. Description: Thermoplastic-insulated wire for use in accordance with Article 310 of NFPA 70.

B. UL ZLGR - Type THHN Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 90 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to

gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

C. UL ZLGR - Type THHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: [**75 deg C**][**90 deg C**].
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.

g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

D. UL ZLGR - Type THW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Service Wire Co.**]
h. [**Southwire Company, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Service Wire Co.**]
h. [**Southwire Company, LLC**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: [**75 deg C**][**90 deg C**].
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.

e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

E. UL ZLGR - Type THW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Service Wire Co.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Service Wire Co.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

F. UL ZLGR - Type THWN Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 75 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

G. UL ZLGR - Type THWN-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
    b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    g. Marked "VW-1," indicating compliance with special vertical flame test.
    h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

H. UL ZLGR - Type TW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Service Wire Co.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Service Wire Co.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 60 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].

e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

I. UL ZLGR - Type FEP Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Covering: None.
c. Insulation Voltage Rating: 600 V.
d. Insulation Temperature Rating: 90 deg C for dry and damp locations.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

J. UL ZLGR - Type FEPB Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Covering: Glass or other suitable braid material.
c. Insulation Voltage Rating: 600 V.
d. Insulation Temperature Rating: 200 deg C for dry locations.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

K. UL ZLGR - Type Z Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**90 deg C for dry and damp locations**][**150 deg C for dry locations and special applications**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.

b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

L. UL ZLGR - Type ZW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**60 deg C**][**75 deg C**][**85 deg C**][**90 deg C**][**150 deg C**][**200 deg C**][**250 deg C**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to

gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

M. UL ZLGR - Type ZW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Okonite Company (The)**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Okonite Company (The)**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**75 deg C for wet locations**][**90 deg C for dry and damp locations**][**150 deg C for dry locations and special applications**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   f. Marked "VW-1," indicating compliance with special vertical flame test.
   g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

N. UL ZLGR - Type TBS Insulated Switchboard Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Prysmian Cables and Systems; Prysmian Group North America**]
    c. [**Southwire Company, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Prysmian Cables and Systems; Prysmian Group North America**]
    c. [**Southwire Company, LLC**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

        1) Thermoplastic and Fibrous Outer Braid: Also investigated in accordance with UL 83B.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    f. Marked "VW-1," indicating compliance with special vertical flame test.
    g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

O. UL ZLGR - Thermoplastic-Insulated Submersible Pump Multiconductor Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cerro Wire LLC**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cerro Wire LLC**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Submersible Pump Cable: Also investigated in accordance with UL CCN FDNP, including NSF 61.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Material: Type THW.
d. Insulation Temperature Rating: 75 deg C.
e. Conductor Material: Copper.
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

2.3 THERMOSET-INSULATED WIRE

A. Description: Thermoset-insulated wire for use in accordance with Article 310 of NFPA 70.

B. UL ZKST - Type RHH Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
    b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    g. Marked "VW-1," indicating compliance with special vertical flame test.
    h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
    i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance

with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

C. UL ZKST - Type RHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 75 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings**].

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.

d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

D. UL ZKST - Type RHW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 90 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

E. UL ZKST - Type SA Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Okonite Company (The)**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Okonite Company (The)**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: [**90 deg C for dry and damp locations**][**200 deg C for special applications**].
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

F. UL ZKST - Type XHH Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Encore Wire Corporation**]
b. [**Okonite Company (The)**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Encore Wire Corporation**]
b. [**Okonite Company (The)**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 90 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

G. UL ZKST - Type XHHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: [**75 deg C for wet locations**][**90 deg C for dry and damp locations**].
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
    b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    g. Marked "VW-1," indicating compliance with special vertical flame test.
    h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
    i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

        1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

H. UL ZKST - Type XHHW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]

h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   g. Marked "VW-1," indicating compliance with special vertical flame test.
   h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
   i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

      1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

I. UL ZKST - Type SIS Insulated Switchboard and Switchgear Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   f. Marked "VW-1," indicating compliance with special vertical flame test.
   g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
   h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

      1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

J. UL ZKST - Thermoset-Insulated Submersible Pump Multiconductor Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Prysmian Cables and Systems; Prysmian Group North America**]
   c. [**Service Wire Co.**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Service Wire Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

1) Submersible Pump Cable: Also investigated in accordance with UL CCN FDNP, including NSF 61.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Material: Type RHW-2.
d. Insulation Temperature Rating: 90 deg C.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

2.4 NONMETALLIC UNDERGROUND CONDUIT WITH CONDUCTORS

A. Nonmetallic Underground Conduit with Conductors, Type NUCC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**Paige Electric Co, LP**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**Paige Electric Co, LP**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Description: A factory assembly of conductors or cables inside a nonmetallic, smooth-wall raceway with a circular cross section.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Type NUCC Conduit with Conductors: UL CCN QQRK, including UL 1990.

5. Standard Features:

a. Referenced Standard: Article 354 of NFPA 70.
b. Conduit Material: [**HDPE-40**][**HDPE-80**][**EPEC-B**].
c. Conduit Sizes: As indicated on the Drawings.
d. Preinstalled Conductors: Provide insulated conductors as indicated on the Drawings.

2.5 METALLIC SHEATHED CABLE

A. UL PJAZ - Metal-Clad Cable, Type MC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Cerro Wire LLC**]
e. [**Copperweld**]
f. [**Encore Wire Corporation**]
g. [**General Cable; Prysmian Group North America**]
h. [**Okonite Company (The)**]
i. [**Southwire Company, LLC**]
j. [**WESCO**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Cerro Wire LLC**]
e. [**Copperweld**]
f. [**Encore Wire Corporation**]
g. [**General Cable; Prysmian Group North America**]
h. [**Okonite Company (The)**]
i. [**Southwire Company, LLC**]
j. [**WESCO**]
k. <**Insert manufacturer's name**>

3. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Metal-Clad Cable: UL CCN PJAZ, including UL 1569.

5. Standard Features:

   a. Referenced Standard: Article 330 of NFPA 70.
   b. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
   c. Conductors: [**Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors**][**Aluminum, complying with ASTM B800 and ASTM B801**].
   d. Ground Conductor: [**Bare**][**Insulated**][**None**].
   e. Conductor Insulation:

      1) Type TFN/THHN/THWN-2. Comply with UL 83.
      2) Type XHHW-2. Comply with UL 44.
      3) <**Insert type and standard**>.

   f. Armor: [**Steel**][**Aluminum**], interlocked.
   g. Jacket: PVC applied over armor.

6. Other Available Features Required by the Project:

   a. Marked "MC-HL," indicating compliance with UL 2225 for use in hazardous (classified) locations.

B. UL AWEZ - Armored Cable, Type AC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Alpha Wire; brand of Belden, Inc.**]
   c. [**Belden Inc.**]
   d. [**Encore Wire Corporation**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Okonite Company (The)**]

g. [**Southwire Company, LLC**]
h. [**WESCO**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Encore Wire Corporation**]
e. [**General Cable; Prysmian Group North America**]
f. [**Okonite Company (The)**]
g. [**Southwire Company, LLC**]
h. [**WESCO**]
i. <**Insert manufacturer's name**>

3. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Armored Cable: UL CCN AWEZ, including UL 4.

5. Standard Features:

a. Referenced Standard: Article 320 of NFPA 70.
b. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
c. Conductors: [**Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors**][**Aluminum, complying with ASTM B800 and ASTM B801**].
d. Ground Conductor: [**Bare**][**Insulated**][**None**].
e. Armor: [**Steel**][**Aluminum**], interlocked.

6. Other Available Features Required by the Project:

a. Marked "LS" or "For Use in Cable Trays," indicating compliance with UL 1685 flame and limited smoke test.

C. UL PPKV and FHJR - Fire-Resistant Mineral-Insulated Metal-Sheathed Cable, Type MI, for Use in Electrical Circuit Integrity Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PYROTENAX; brand of nVent Electrical plc**]
b. [**TEC International**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**PYROTENAX; brand of nVent Electrical plc**]
b. [**TEC International**]
c. <**Insert manufacturer's name**>

3. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Mineral-Insulated Metal-Sheathed Cable: UL CCN PPKV, including UL Subject 504.
b. Circuit Integrity: UL CCN FHJR, including UL 2196.

5. Standard Features:

a. Referenced Standard: Article 332 of NFPA 70.
b. Fire-Resistance Rating: [**1 h**][**2 h**].
c. Conductors: Copper, complying with ASTM B3 for bare annealed copper.
d. Insulation: [**Compressed magnesium oxide**]<**Insert material**>.
e. Sheath: [**Copper**]<**Insert material**>.

D. UL PJAZ and FHJR - Fire-Resistant Metal-Clad Cable, Type MC, for Use in Electrical Circuit Integrity Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. <**Insert manufacturer's name**>

3. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Metal-Clad Cable: UL CCN PJAZ, including UL 1569.
b. Circuit Integrity: UL CCN FHJR, including UL 2196.

5. Standard Features:

a. Referenced Standard: Article 330 of NFPA 70.

b. Fire-Resistance Rating: [**1 h**][**2 h**].
c. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
d. Conductors: [**Copper**][**Copper-clad aluminum**].
e. Ground Conductor: [**Bare**][**Insulated**][**None**].
f. Armor: [**Steel**][**Aluminum**], interlocked.
g. Jacket: PVC applied over armor.

6. Other Available Features Required by the Project:

a. Marked "MC-HL," indicating compliance with UL 2225 for use in hazardous (classified) locations.

2.6 PHOTOVOLTAIC SINGLE-CONDUCTOR CABLE

A. Photovoltaic Single-Conductor Cable, Type PV :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Copperweld**]
b. [**Encore Wire Corporation**]
c. [**General Cable; Prysmian Group North America**]
d. [**Service Wire Co.**]
e. [**Southwire Company, LLC**]
f. [**WESCO**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Copperweld**]
b. [**Encore Wire Corporation**]
c. [**General Cable; Prysmian Group North America**]
d. [**Service Wire Co.**]
e. [**Southwire Company, LLC**]
f. [**WESCO**]
g. <**Insert manufacturer's name**>

3. Description: Flexible, insulated and uninsulated, drawn-copper current-carrying conductor with an overall insulation layer or jacket, or both, rated [**2000**][**600**] V.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Photovoltaic Wire: UL CCN ZKLA, including UL 4703.

5. Standard Features:

a. Referenced Standard: Article 609 of NFPA 70.
b. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

2.7 NONMETALLIC JACKETED CABLE

A. UL PWVX - Nonmetallic-Sheathed Cable, Type NM-B and Type NMC-B :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Copperweld**]
    d. [**Encore Wire Corporation**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Republic Wire Inc.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Copperweld**]
    d. [**Encore Wire Corporation**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Republic Wire Inc.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Type NM-B and Type NMC-B Cables: UL CCN PWVX, including UL 719.

4. Standard Features:

    a. Referenced Standard: Article 334 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: Individual conductors are rated 90 deg C for multiple conductor ampacity calculations; however, final cable ampacity rating must not exceed value for 60 deg C in Table 310.15(C)(1) of NFPA 70.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

    f. Cable Covering:

        1) Type NM-B: Flame retardant and moisture resistant.
        2) Type NMC-B: Flame retardant, moisture resistant, fungus resistant, and corrosion resistant.

B. UL YDUX - Underground Feeder and Branch-Circuit Cable, Type UF and Type UF-B :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Copperweld**]
   e. [**Encore Wire Corporation**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Republic Wire Inc.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Copperweld**]
   e. [**Encore Wire Corporation**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Republic Wire Inc.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type UF and Type UF-B Cables: UL CCN YDUX, including UL 493.

4. Standard Features:

   a. Referenced Standard: Article 340 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating:

      1) Type UF: 60 deg C.
      2) Type UF-B: Individual conductors are rated 90 deg C for multiple conductor ampacity calculations; however, final cable ampacity rating must not exceed value for 60 deg C in Table 310.15(C)(1) of NFPA 70.

   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

   f. Cable Covering: Flame retardant, moisture resistant, fungus resistant, corrosion resistant, and suitable for direct burial in the earth.

C. UL TYLZ - Service-Entrance Cable, Type SE, Type USE, and Type USE-2 :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Republic Wire Inc.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Republic Wire Inc.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Service-Entrance Cable: UL CCN TYLZ, including UL 854.

4. Standard Features:

    a. Referenced Standard: Article 338 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: Not in excess of rating for insulation type specified below:

        1) Type THWN: 75 deg C, dry and wet locations.
        2) Type THWN-2: 90 deg C, dry and wet locations.
        3) Type RHW: 75 deg C, dry and wet locations.
        4) Type XHHW: 90 deg C, dry and damp locations; 75 deg C, wet locations.
        5) Type RHW-2: 90 deg C, dry and wet locations.
        6) Type XHHW-2: 90 deg C, dry and wet locations.

    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Style R," indicating that cable assembly includes uninsulated equipment ground conductor with insulated conductors.
b. Marked "Style U," indicating that cable assembly includes uninsulated equipment ground conductor helically wrapped over insulated conductors.
c. Marked "-HF," indicating that combustible materials are halogen-free when tested in accordance with UL Subject 2885.

1) Marked "-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

D. UL QPOR - Power and Control Tray Cable, Type TC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Encore Wire Corporation**]
d. [**General Cable; Prysmian Group North America**]
e. [**Okonite Company (The)**]
f. [**Southwire Company, LLC**]
g. [**WESCO**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Encore Wire Corporation**]
d. [**General Cable; Prysmian Group North America**]
e. [**Okonite Company (The)**]
f. [**Southwire Company, LLC**]
g. [**WESCO**]
h. <**Insert manufacturer's name**>

3. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Power and Control Tray Cable: UL CCN QPOR, including UL 1277.

5. Standard Features:

a. Comply with NEMA WC 57/ICEA S-73-532 for Type TC cables used for control, thermocouple extension, and instrumentation.
b. Comply with NEMA WC 70/ICEA S-95-658 for Type TC cables used for power distribution.

c. Conductors: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
d. Ground Conductor: [**Bare**][**Insulated**][**None**].
e. Conductor Insulation: Type XHHW-2. Comply with UL 44.

6. Other Available Features Required by the Project:

a. Marked "TC-ER," indicating that cable is designed for use with ASDs, with oversized crosslinked polyethylene insulation, [**spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire**][**dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires**], and sunlight- and oil-resistant outer PVC jacket.

1) Marked "TC-ER-JP," indicating that cable is also suitable for pulling through structural members in accordance with Article 336.10(9) of NFPA 70.
2) Marked "TC-ER-HL," indicating that cable is also suitable for use in hazardous (classified) environments.

b. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
c. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

2.8 CONNECTORS AND SPLICES

A. UL PJOX - Armored and Metal-Clad Cable Fittings :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Installation Products**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**American Fittings Corp. (AMFICO)**]
d. [**Arlington Industries, Inc.**]
e. [**Bridgeport Fittings Inc.**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Halex; division of Scott Fetzer Co.**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**O-Z/Gedney; brand of Appleton Group**]
j. [**Service Wire Co.**]
k. [**SIGMA Engineered Solutions**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Installation Products**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**American Fittings Corp. (AMFICO)**]
d. [**Arlington Industries, Inc.**]

e. [**Bridgeport Fittings Inc.**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Halex; division of Scott Fetzer Co.**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**O-Z/Gedney; brand of Appleton Group**]
j. [**Service Wire Co.**]
k. [**SIGMA Engineered Solutions**]
l. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type AC and Type MC Cable Connectors: UL CCN PJOX, including UL 514B.

4. Standard Features: For steel and aluminum sheathed cables, designed to connect conductors specified in this Section.

B. UL PPYT - Mineral-Insulated Metallic-Sheathed Cable Fittings :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**TEC International**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**TEC International**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type MI Cable Fittings: UL CCN PPYT, including UL 514B.

4. Standard Features: For copper sheathed cables, designed to connect conductors specified in this Section.

C. UL ZMVV - Wire Connectors and Soldering Lugs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Installation Products**]
   b. [**Amphenol TPC Wire & Cable**]
   c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Eaton**]
   e. [**Fastenal Co.**]

f. [**Gardner Bender; brand of ECM Industries LLC; division of nVent Electric plc**]
g. [**Hillsdale Terminal**]
h. [**Ideal Industries, Inc.**]
i. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
j. [**Marinco Power Products**]
k. [**Morris Products Inc.**]
l. [**Newark; an Avnet Company**]
m. [**Panduit Corp**]
n. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
o. [**TE Connectivity Ltd.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Installation Products**]
b. [**Amphenol TPC Wire & Cable**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Eaton**]
e. [**Fastenal Co.**]
f. [**Gardner Bender; brand of ECM Industries LLC; division of nVent Electric plc**]
g. [**Hillsdale Terminal**]
h. [**Ideal Industries, Inc.**]
i. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
j. [**Marinco Power Products**]
k. [**Morris Products Inc.**]
l. [**Newark; an Avnet Company**]
m. [**Panduit Corp**]
n. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
o. [**TE Connectivity Ltd.**]
p. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Wire Connectors and Soldering Lugs: UL CCN ZMVV, including UL 486A-486B or UL 486C.

4. Standard Features:

a. One piece, seamless, designed to terminate conductors specified in this Section.
b. Material: [**Copper**][**Aluminum**][**Bronze**].
c. Type: [**One**][**Two**] hole with [**standard**][**long**] barrels.
d. Termination: [**Compression**][**Crimp**].

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper, aluminum, or copper-clad aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].

a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
b. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. PV Circuits: [**Copper**][**Aluminum**][**Copper-clad aluminum**]; Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Type USE, single conductor in raceway**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Multiconductor cable, Type SE**].

B. Exposed Feeders: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Underground feeder cable, Type UF**].

E. Feeders Installed below Raised Flooring: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**].

F. Feeders in Cable Tray: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors larger than No. 1/0 AWG**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

G. Exposed Branch Circuits, Including in Crawlspaces: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Underground branch-circuit cable, Type UF**].

J. Branch Circuits Installed below Raised Flooring: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**].

K. Branch Circuits in Cable Tray: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors larger than No. 1/0 AWG**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

M. ASD Output Circuits: [**Type XHHW-2 in metal conduit**][**Type TC-ER cable with braided shield**][**Type TC-ER cable with dual tape shield**].

N. PV Circuits, Type USE-2: For PV source circuits rated at 600 V or less.

O. PV Circuits, Type PV: For PV source circuits rated at [**600**][**1000**][**2000**] V.

3.3 INSTALLATION OF LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installation of Type AC and Type MC Cables: NECA NEIS 120.
9. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
2. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
6. Provide support for cables.
7. Complete cable tray systems installation prior to installing conductors and cables.
8. Connections:

    a. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

b. Make splices, terminations, and taps that are compatible with conductor material[**and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors**].

1) Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

9. Wiring at Outlets: Install conductor at each outlet, with at least [**6 inch (150 mm)**][**12 inch (300 mm)**] of slack.

D. Interfaces with Other Work:

1. Identification:

a. Identify and color-code conductors and cables.
b. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

2. Sleeves and Sleeve Seals: Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
3. Firestopping: Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
3. After installing conductors and cables and before electrical circuitry has been energized, test [**service entrance and feeder conductors**][**and**][**conductors**] feeding the following critical equipment and services for compliance with requirements:

a. <**Insert, in separate subparagraphs, critical equipment and services to be tested**>.

4. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection in accordance with the single-line diagram.
b. Test bolted connections for high resistance using one or more of the following:

1) A low-resistance ohmmeter.
2) Calibrated torque wrench.
3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.
f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.
h. Uniform resistance of parallel conductors.

E. Nonconforming Work:

1. Wire or cable assembly will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 MAINTENANCE

A. Infrared Scanning of Splices: Two months after Substantial Completion, perform infrared scan of splices, joints, and connections in conductors 3 AWG and larger. Remove covers so splices, joints, and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison. Correct deficiencies determined during the scan.

1. Follow-On Infrared Scanning: Perform follow-up infrared scan of splices at 11 months after Substantial Completion.
2. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies cables splices checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 05 19 00

Task	Specification	Specification Description
26 05 19 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 19 13 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Underfloor raceway products.
2. Underfloor raceway fittings.
3. Maintenance material items.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. [**Section 013100 "Project Management and Coordination"**] specifies preinstallation conference procedures.
3. Section 033000 "Cast-in-Place Concrete" specifies installation of concrete surrounding underfloor raceways.
4. Section 034100 "Precast Structural Concrete" specifies precast concrete units used as cellular concrete floor raceways.
5. Section 053100 "Steel Decking" specifies rough-in of underfloor duct distribution system.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies installation of wiring for the Work specified in this Section.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies installation of grounding and bonding for the Work specified in this Section.
8. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies installation of cover plates for outlet, device, and junction boxes.
9. Section 260553 "Identification for Electrical Systems" specifies installation of labels and warning signs for the Work specified in this Section.
10. Section 262726 "Wiring Devices" specifies installation of receptacles and connectors.
11. Section 271513 "Communications Copper Horizontal Cabling" specifies installation of twisted pair jacks, outlets, assemblies, and cover plates.
12. Section 271523 "Communications Optical Fiber Horizontal Cabling" specifies installation of optical fiber jacks, outlets, assemblies, and cover plates.
13. Section 271533 "Communications Coaxial Horizontal Cabling" specifies installation of coaxial jacks, outlets, assemblies, and cover plates.

1.2 DEFINITIONS

A. Activation: Nomenclature used by some manufacturers for a service fitting.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at the Project site**][**by web conference**].

B. Preinstallation Coordination Meeting(s): For coordination of structural, electrical, and interior finishes Work for installation of underfloor raceways. Conduct meeting(s) [**at the Project site**][**as web conference**].

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect [**Construction Manager**][**and the Owner]** of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.
3. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents Detailing Fabrication and Assembly of Underfloor Raceways:

a. Include floor plans, elevations, sections, and details.
b. Identify components and accessories, such as expansion-joint assemblies, straight raceway lengths, preset and afterset inserts, and service fittings.
c. Detail preparation and installation methods and instructions.
d. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
e. Provide raceway fill charts for each duct size provided for each conductor size the duct is identified to accept. Provide separate charts for power and communication conductors and cables.
f. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements, including slab reinforcement, floor finish work, permanent partitions, expansion joints [**architectural module lines**][**and pretensioning or post-tensioning components**] .
g. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
h. Indicate thickening of slabs where required for adequate encasement of raceway components.
i. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
j. Revise locations from those indicated in the Contract Documents, as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
k. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.

l. Identify those cells of cellular floor deck that are to be connected and fitted for the following underfloor distribution:

1) Power.
2) Voice.
3) Data.
4) Signal.
5) Communications.

C. Samples for Verification: For each underfloor raceway product, in specified finish, including the following:

1. Service fittings and flush and recessed outlet and junction-box covers.
2. A section of each service raceway configuration, with specified preset insert and service fitting installed.
3. A junction box of each size and type for use with underfloor raceway.
4. A section of each header raceway configuration, complete with provisions for connection with service raceway.
5. A section of trench-type raceway, complete with cover and required trim.
6. A junction box of each size and type for use with trench-type raceway, complete with cover and trim.

D. Field QC Reports: For specified tests and inspections.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: For each type of specified product.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For underfloor raceways.

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:

a. Manufacturer's published instructions for locating preset inserts and for installing afterset inserts.
b. Dimensioned locations for all ducts, junction boxes, and preset inserts. Typical spacing designation must be accepted only for preset insert spacing along a continuous length of duct.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] .

2. Component Importance Factor (Ip): [**1.0**][**1.5**] .

3. Component Amplification Factor (ap): [**1.0**][**2.5**].

4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 UNDERFLOOR RACEWAY PRODUCTS

A. Flat-Top, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**MonoSystems, Inc**]
b. [**Square D; Schneider Electric USA**]
c. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

    a. Product Reference Standard(s): Article 390 of NFPA 70.
    b. Configuration: Steel, rectangular, flat-top, single-channel raceways with premanufactured inserts.
    c. Materials: One-piece, continuous weld, minimum **0.0598 inch (1.5 mm)** thick steel, with [**corrosion-resistant**][**galvanized**] coating inside and out after welding.
    d. Cross-Section Shape: Rectangular, with rounded corners.

    e. Number of Longitudinal Channels: [**Two**][**Three**][**Four**] , separated by steel wall(s).

    f. Number of Levels: [**One**][**Two**] .

    g. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks must provide a [**2 inch (50 mm)**] minimum bending radius for communication cables.

5. Service Raceways: Fitted with preset inserts.

    a. Nominal Multichannel Underfloor Raceway Dimensions:

        1) Depth: **1-3/8 inch (35 mm)**.
        2) Overall Width: [**6 inch (150 mm)**][**10 inch (250 mm)**][**15 inch (375 mm)**].
        3) Power Service Channel Width: [**3-1/2 inch (88 mm)**][**4-3/8 inch (110 mm)**].
        4) Communication Service Channel Width: [**3-1/2 inch (88 mm)**][**4 inch (100 mm)**][**6-1/2 inch (163 mm)**].

    b. Nominal Single-Channel Underfloor Raceway Dimensions:

        1) Depth: **1-1/2 inch (38 mm)**.
        2) Power Service Raceway Width: **3-1/4 inch (81 mm)**.
        3) Communication Service Raceway Width: [**3-1/4 inch (81 mm)**][**6 inch (150 mm)**] .

        4) Number of Single-Channel Raceways per Run: [**One**][**Two**][**Three**][**Four**][**Five**] unless otherwise indicated.

    c. Preset Inserts: [**Rectangular**][**Round**] .

        1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**] on center.

            a) Rectangular Insert Size: Rectangular dimensions as required to accommodate mounting and connection of flush- and surface-mounted, [**single-**][**and multiple-**] outlet service fittings or to connect to wiring extensions for feeding wall outlets for [**power**][**communications**][**power and**

communications].

b) Round Insert Size: [**2 inch (50 mm)**] in diameter.

2) Equip each insert with a disposable cover, and select insert height so cover is **1/8 inch (3 mm)** below surface of concrete.

3) Arrange insert for optional attachment of flush-, surface-, or wiring-extension service fitting to replace disposable cover. Arrange brackets, mountings, barriers, and floor access covers to support, isolate, and provide access to [**flush**][**surface**] outlet-mounting connector, jack, and receptacle devices.

6. Header Raceways: [**Single-**][**Multi**] channel, without preset inserts (blank raceway).

a. Nominal Raceway Dimensions:

1) Depth: [**Same as service raceways**][**2-1/2 inch (63 mm)**][**2-3/4 inch (69 mm)**][**3 inch (75 mm)**][**3-1/2 inch (88 mm)**] .

2) Power Header Raceway Width: [**3-1/2 inch (88 mm)**][**4-3/8 inch (110 mm)**].

3) Communication Header Raceway Width: [**3-1/2 inch (88 mm)**][**4 inch (100 mm)**][**6-1/2 inch (163 mm)**] .

b. Arrangement: [**In same plane as**][**Below**] service raceways.

c. Connections: Arranged to connect with service raceways at [**single**][**two**] -level junction boxes.

B. Flush, Flat-Top, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.

3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

a. Configuration: [**Single**][**multichannel**] underfloor raceways installed on floor slab with top of raceway flush with concrete topping added hereafter, and then covered with finish material.

b. Material: Steel.

c. Cross-Section Shape: Rectangular, [**single channel**][**and**][**multichannel, separated by steel wall(s)**] .

d. Listed and labeled for installation with top flush with concrete floor.

e. Number of Levels: One.

5. Service Raceways: Fitted with preset inserts.

    a. Number of Longitudinal Channels per Multichannel Raceway: [**Two**][**Three**] .

    b. Number of Single-Channel Raceways per Run: [**One**][**Two**][**Three**] unless otherwise indicated.
    c. Nominal Channel Dimensions: **3 inch (75 mm)** wide by **1-1/4 inch (31 mm)** deep.
    d. Preset Inserts: Threaded opening with removable steel plug that is flush with top of raceway when screwed in place.

        1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**] on center, full length of each service raceway.
        2) Arrangement: Stagger insert locations on parallel raceways or channels to accommodate placement of adjacent service fittings.
        3) Size: **1-5/8 inch (41 mm)** diameter.

6. Trench Duct Crossunder: Fitting attached to underside of trench duct.

    a. Nominal Channel Dimensions: Same as service raceways.
    b. Arrangement: Offset by depth of trench duct.
    c. Connections: Arranged to connect trench duct to flush duct through factory-cut, grommeted openings.

7. Header Raceways: Raceways same as service raceways, except without preset inserts (blank raceway).

    a. Nominal Channel Dimensions: Same as service raceways.
    b. Arrangement: In same plane as service raceways.
    c. Connections: Arranged to connect with service raceways at junction boxes.

C. Cellular Metal, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ASC Steel Deck; ASC Profiles, LLC**]
    b. [**Dennis Filges Company, Inc**]
    c. [**Epic Metals Corporation**]
    d. [**HH Robertson**]
    e. [**United Steel Deck, Inc.**]
    f. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

a. Configuration: Multichannel, cellular, underfloor service raceways installed on floor slab with top of raceway flush concrete topping added hereafter, and then covered with finish material.
b. Material:

1) Galvanized-steel sheet, ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)** minimum, [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
2) Galvanized- and shop-primed steel sheet, ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, **G60 (Z180)** zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.

c. Number of Longitudinal Cells: Three, separated by steel walls.
d. Nominal Dimensions of Cells:

1) Overall Depth: **1-1/4 inch (31 mm)** unless otherwise indicated.
2) Cross-Sectional Area of Cells: Power cells: **5-1/2 sq. inch (34.4 sq. cm)**; communication system cells: **16 sq. inch (100 sq. cm)**.

e. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks must provide a [**2 inch (50 mm)**] minimum bending radius for communication cables.

5. Service Raceways: Fitted with preset inserts.

a. Preset Inserts: Rectangular-shaped metal housing assemblies arranged to provide electrical outlet access to each cell of each raceway designated for service raceway use. Inserts must be provided throughout the entire length of each such raceway.

1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**] on center.
2) Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-outlet service fitting.
3) Include mounting and connecting provisions for a surface, single- or multiple-outlet service fitting.
4) Include connecting provisions for a wiring-extension service fitting to feed wall outlets.
5) Equip each insert with a disposable cover plate arranged for installation with top **1/8 inch (3 mm)** below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable top.

6. Header Assembly: A junction box and raceway arrangement positioned to feed wires and cables to service raceways.

a. Three-compartment junction box connecting blank, [**multicell cellular**][**flat-top, multichannel**] header raceway (no inserts) with cellular service raceways at right angles to header raceway.
b. Cellular header raceway must be made of the same material and have the same nominal dimensions as service raceways.
c. Provide capability for service raceways to be run in both perpendicular directions at the intersection with header raceway.

D. Trench-Type, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Dennis Filges Company, Inc**]
b. [**HH Robertson**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Square D; Schneider Electric USA**]
e. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

   a. Configuration: Trench-type raceways used as header or feeder raceways to serve service raceways.
   b. Trench: Steel, shop or factory welded and fabricated to indicated sizes. Include the following features:

      1) Slab Depth Adjustment: Minimum of minus **1/8 inch (3 mm)** to plus **5/8 inch (17 mm)** before and during concrete placement.
      2) Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.
      3) Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
      4) Trim Strip: Select to accommodate floor finish material.
      5) Partitions: Arranged to separate channels and isolate wiring of different systems.

      6) Grommeted openings in active floor cells or service raceways.
      7) Manufacturer's standard corrosion-resistant finish, applied after fabrication.

   c. Cover Plates: Removable, steel plates, **1/4 inch (6 mm)** thick, each weighing **60 lb. (27 kg)** or less with full gasket attached to side units. Fabricate intermediate supports to limit unsupported spans to [**15 inch (375 mm)**] or less. Fabricate covers with appropriate depth recess to receive indicated floor finish.

2.3 UNDERFLOOR RACEWAY FITTINGS

A. Electrical Connection Components for Cellular Steel Floor Decks:

1. Source Limitations for Electrified Cellular Steel Floor-Deck Components: Obtain electrical components, such as preset inserts, afterset inserts, service fittings, header ducts, and trench header ducts, from cellular steel floor-deck manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Preset Inserts: Rectangular metal-housing assemblies.

1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**] on center.
2) Size: As required to provide electrical outlet access to each cell of each group of three cells that is designated for electrical service raceway use.
3) Equip each insert with a disposable cover arranged for installation with top **1/8 inch (3 mm)** below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable cover.

4) Include housing and connecting provisions for a [**flush or recessed**][**surface**] service fitting, [**single**][**double**][**triple**] outlet.
5) Include connecting provisions for a wiring-extension service fitting to feed wall outlets.

B. Electrical Connection Components for Cellular Concrete Floor Decks:

1. Source Limitations for Electrified Cellular Concrete Floor-Deck Components: Obtain electrical components, such as preset inserts, afterset inserts, service fittings, header ducts, and trench header ducts, from cellular concrete floor-deck manufacturer or from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Afterset Inserts: Round metal-nipple assembly with internal and external threading, arranged to screw into plug driven into **1-7/8 inch (47 mm)** hole drilled through floor fill, where present, and deck-cell wall into floor raceway cell.

1) Inserts must be compatible with floor-mounting service fittings.
2) Inserts must provide wiring path from cell to [**power**][**communication**][**power and communication**]
[**wall**][**and**][**ceiling**] outlets.
3) Inserts must provide wiring path from cell to header raceway.

C. Underfloor Raceway Service Fittings/Activations:

1. Source Limitations: Obtain underfloor raceway service fittings and hardware for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Exposed Parts Finish: [**Brass**][**Brushed aluminum**].

c. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.

1) Connector, Jack, and Receptacle Devices: Single modular type.
2) Power Receptacle Outlet: Suitable for 20 A, 120 V device.

d. Flush System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.

1) System Type: [**Single**][**multiple**] .
2) Connector, Jack, and Receptacle Devices: Modular type.
3) Power Receptacle Rating: 20 A, 120 V unless otherwise indicated.

4) Recess-Mounted Service Fitting: Modular fittings compatible with preset inserts. Include device plates for indicated systems and provisions for receptacles, jacks, and connectors. Include hinged flush covers with recessed depth to match thickness of floor finish material. Provide for internally mounted receptacle- and communication-jack and connector assemblies.

e. Surface-Mounted Service Fitting: Modular pedestal type, with locking attachment matched to insert floor opening.

1) Power-outlet, double-faced, surface-mounted unit for duplex receptacle on both sides.
2) Power-outlet, single-faced, surface-mounted unit for duplex receptacle on one side.
3) Communication-outlet, double-faced, surface-mounted unit.

a) Include bushed openings on both sides; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
b) Include provisions for modular dual fiber-optic connector assembly on both sides.
c) Include provisions for modular dual jack-connector assembly, rated for [**Category 5**][**Category 5e**][**Category 6**] on both sides.

4) Communication-outlet, single-faced, surface-mounted unit with bushed opening on one side; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
5) Combination surface-mounted unit for duplex receptacle on one side and with communication cable connection provision on opposite side.

a) Include bushed opening; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
b) Include provisions for modular dual fiber-optic connector assembly.
c) Include provisions for modular dual jack-connector assembly, rated for

[**Category 5**][**Category 5e**][**Category 6**] .

6) Flush-Mounted Service Fittings: Modular fittings compatible with preset inserts and must include covers, provisions for receptacles jacks and connector assemblies and wiring extensions to wall-mounted outlets, and associated device plates for indicated systems. Include flush covers, recessed to suit floor finish material.

7) Wiring-Extension Service Fittings: Arrangement of brackets and mountings to support and provide access to wiring or cabling of a cell, and to connect the cable or raceway that extends the system to an individual wall outlet. Provide for connection of [**ERMC**][**FMC**][**ENT**][**Type MC cable**] for power extensions, and [**ERMC**][**FMC**][**ENT**][**optical fiber/communication cable raceway**] for communication system extensions.

D. Underfloor Raceway Adapter Fittings:

1. Source Limitations: Obtain underfloor raceway adapter fittings for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Description: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.
c. Compatible with raceway and outlet system and must be listed for use with raceway systems and components delivered.

E. Underfloor Raceway Supports and Hardware:

1. Source Limitations: Obtain underfloor raceway supports and hardware components for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Supports and hardware must be compatible with raceway and outlet system and must be listed for use with raceway systems and components delivered.
c. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.

F. Underfloor Raceway Junction Boxes:

1. Configuration: Raceway manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:

a. Mounting brackets.
b. Escutcheons and holders to accommodate surrounding floor covering.
c. Means for leveling and height adjustment more than **3/8 inch (10 mm)** before and after concrete is placed.
d. Boxes must withstand a minimum [**300 lb (136 kg)**] concentrated load. Internal supports must be provided as needed to meet this requirement.
e. All boxes must provide **2 inch (50 mm)** minimum bend radius for data and communication cables.
f. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.

g. Covers must have appropriate depth recess to receive specific floor finish material.
h. Partitions to separate wiring of different systems.

2.4 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to the Owner spare parts, for repairing underfloor raceway, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Afterset Inserts:

a. Furnish quantity equal to [**10**] percent of service fittings installed, but no fewer than units.
b. Furnish quantity equal to [**5**] percent of each type of preset insert installed, but no fewer than units.

2. Service Fittings: Furnish [**three**] of each type of service fitting indicated for each **100 ft (30 m)** of distribution raceway or active-floor-cell length.
3. Outlet Blanking Covers: Furnish quantity equal to [**10**] percent of each type of floor opening installed for outlets.

B. Special Tools: Furnish to the Owner proprietary or special equipment required to operate, maintain, repair, adjust, or implement future changes to underfloor raceway, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Electronic Instruments: Furnish [**one**] electronic instrument(s) and accessories, in accordance with underfloor raceway manufacturer's published instructions for detecting, locating, and uncovering preset inserts in metal raceway under floor covering and up to **3/8 inch (10 mm)** of concrete fill.
2. Electric Drill: Furnish [**one**] variable-speed electric drill(s), **1/2 inch (13 mm)** capacity.

3. Hole Saw: Furnish [**one**] diamond bit hole saw(s), for dry concrete, [**2 inch (50 mm)**] size.
4. Afterset Insert Installation Tool: Furnish [**one**] installation tool(s) selected in accordance with manufacturer's published instructions for installing afterset inserts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Communications Work: BICSI N1.
8. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
12. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
13. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for underfloor raceway products and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

    d. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.

        1) Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
        2) Install markers flush at screed line before pouring slab or placing fill. Extend marker with grommeted screw when floor covering is placed. Do not extend through carpet.
        3) Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications.
        4) Use another distinctive screw head to identify third system, such as special-purpose wiring.

2. Grounding and Bonding:

a. Equipment Grounding Conductors: Provide and route insulated equipment grounding conductors with other feeder or branch circuit conductors. Bond equipment grounding conductor to underfloor raceway products using provided hardware in accordance with manufacturer's published instructions.
b. Equipment Bonding Conductors: Provide equipment bonding straps or jumpers where additional bonding is indicated on the Drawings between underfloor raceway products and adjacent metallic equipment, enclosures, piping, or building structure. Route bonding conductors along shortest and straightest paths possible unless otherwise indicated or required by NFPA 70. Avoid obstructing access panels or placing conductors where they may be subjected to strain, impact, or damage.

3. Coordinate installation of new underfloor raceway products with existing conditions.
4. Coordinate installation of underfloor raceway products with installation of concrete.

3.3 INSTALLATION OF UNDERFLOOR RACEWAY PRODUCTS

A. Install underfloor raceway products aligned and leveled and, unless otherwise indicated, parallel or perpendicular to floor supports.

B. Maintain arrangement of conductor services throughout the raceway system.

C. Install a concrete mud slab for support of cellular metal, flush duct, or trench duct raceway. Construct mud slab with wire mesh in the top **1 inch (25 mm)** of concrete.

D. Install a vapor barrier between the cellular metal raceway and a substrate in contact with earth.

E. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Fasten supports securely at ends and at intervals not to exceed **60 inch (1500 mm)**, to prevent movement during concrete pour.

F. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.

G. Underfloor Raceway Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of the Work.

H. Install preset inserts per manufacturer's instructions.

I. Adjust supports to maintain a **1/8 to 3/8 inch (3.0 to 10 mm)** finished concrete cover over preset inserts.

J. Remove burrs, sharp edges, dents, and mechanical defects.

K. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.

L. Install expansion fittings with suitable bonding jumper where raceways cross building expansion joints.

M. Ground and bond underfloor raceway components to create a continuous bonding path.

N. Seal raceways, cells, junction boxes, and inserts to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill. Tape joints or seal with compound, in accordance with underfloor raceway manufacturer's published instructions.

O. Install concrete surrounding underfloor raceways.

P. Afterset Inserts: Cut, hole saw, and drill slab and raceways to allow for installation at locations indicated on plans.

Q. Wiring must comply with NFPA 70 requirements for wet locations.

1. Install wiring from outlet insert toward junction boxes, then to termination at panel.
2. Splices: All splices and taps must be made in junction boxes. No splices or taps must be made in raceways or outlet inserts.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections, including Grounding:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field QC tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**], as directed by the Owner.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform visual inspection of interior of each [**junction box**][**section of trench raceway**] to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
3. Prior to and after concrete pour, perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.

    a. Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 Ω.
    b. Comply with NETA Acceptance Testing Specification about safety, suitability of test equipment, test instrument calibration, and test report and records.

D. Nonconforming Work:

1. Underfloor raceway products will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field QC Reports: Collect, assemble, and submit test and inspection reports.

3.5 CLEANING

A. Clean and swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

3.6 PROTECTION

A. Protect underfloor raceway products from damage. Do not use the installed duct system as working platforms or walkways. Do not allow equipment or heavy traffic over duct during construction period, without first installing ramps over the duct. Ramps must be designed so that imposed loads are not transferred to the duct. Components of the system that are damaged during construction must be replaced.

END OF SECTION 26 05 19 13

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Task	Specification	Specification Description
26 05 19 13	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 19 13	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 19 16 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications-circuit accessories.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 061000 "Rough Carpentry" furnishes equipment backing panels installed by this Section.
6. Section 260526 "Grounding and Bonding for Electrical Systems" specifies the following installed by this Section:

    a. Grounding and bonding conductors.
    b. Grounding and bonding clamps.
    c. Grounding and bonding bushings.
    d. Grounding and bonding hubs.
    e. Grounding and bonding connectors.
    f. Intersystem bonding bridge grounding connector.
    g. Grounding and bonding busbars.
    h. Signal reference grids.

7. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases for communications equipment installed by this Section.
8. Section 260533.16 "Boxes and Covers for Electrical Systems" furnishes the following installed by this Section:

    a. Metallic outlet boxes, device boxes, rings, and covers.
    b. Junction boxes and pull boxes.
    c. Cover plates for device boxes.

9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies labels and warning signs for communications pathways installed by this Section.
11. Section 262716 "Electrical Cabinets and Enclosures" specifies the following installed by this Section:

    a. Cabinets and cutout boxes.
    b. Termination boxes.
    c. Miscellaneous enclosures.

d. Rack or frame systems.
e. Enclosure-mounted relocatable power taps.

12. Section 262719 "Multi-Outlet Assemblies" specifies the following installed by this Section:

    a. Wall-mounted, surface metal raceway multi-outlet assemblies.
    b. Indoor service poles.

13. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" specifies duplex receptacles installed by this Section.
14. Section 262726.39 "Locking Receptacles" specifies locking receptacles installed by this Section.
15. Section 262726.51 "Connectors, Cords, and Plugs" specifies pendant flexible cords and connectors installed by this Section.
16. Section 270528 "Pathways for Communications Systems" specifies cable pathways serving communications equipment room fittings installed under this Section.

1.2 DEFINITIONS

A. Abbreviations for Communications Spaces:

1. EF: Entrance facility; generally serves campus or building. EF may include an ER.
2. ER: Equipment room; generally serves campus or building.
3. TE: Telecommunications enclosure; generally serves a single tenant or floor.
4. TR: Telecommunications room; generally serves a single tenant or floor.

B. Abbreviations for Communications Facilities:

1. HC: Horizontal cross-connect; also called "floor distributor" (FD).
2. IC: Intermediate cross-connect; also called "building distributor" (BD).
3. MC: Main cross-connect; also called "campus distributor" (CD).

C. Abbreviations for Grounding and Bonding:

1. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
2. PBB: Primary bonding busbar; located in main distribution frame room, ideally near electrical service entrance.
3. RBB: Rack bonding busbar; located in equipment cabinets and racks.
4. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
5. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
6. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
7. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
8. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For communications equipment room planning. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Representative of Owner's information and communications technology staff[**that will be installing electronic equipment**][**and cables**], installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Communications Equipment Room Drawings, Diagrams, and Supporting Documents:

a. Include plans, elevations, sections, details, and attachments to other work.
b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Equipment Racks and Cabinets: Indicate workspace requirements and access for cable connections.
d. Switchboards, Panelboards, and Safety Switches: Indicate workspace requirements and access for cable connections.
e. Grounding and Bonding: Indicate location of busbars and their mounting details showing standoff insulators and wall mounting brackets.
f. Cable Trays, Large Raceways, Ducts, and Piping: Indicate elevation and route of vertical and horizontal cable trays, raceways or ducts larger than **2 inch (50 mm)** wide, and fire-suppression piping located inside communications equipment room.
g. Luminaires: Indicate elevation, orientation, and size of luminaires inside the communications equipment room for coordination with cable trays, equipment racks, cabinets, and other equipment.
h. Access Panels: Indicate locations, dimensions, and clearances required to open access panels in ducts, walls, or ceilings inside communications equipment room.
i. Controls: Indicate locations of sensors, switches, and push-buttons for HVAC, fire suppression, fire alarm, and standby power.
j. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
k. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
l. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 COMMUNICATIONS-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for connecting communications circuits in accordance with Article 800 of NFPA 70.

B. UL DUXR - 66-Style or 110-Style Cross-Connect Frame :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Canada ULC**]
b. [**CommScope, Inc**]
c. [**Optical Cable Corporation (OCC)**]
d. [**Ortronics, Inc.**]
e. [**Panduit Corp**]
f. [**Siemon Co. (The)**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Canada ULC**]
b. [**CommScope, Inc**]
c. [**Optical Cable Corporation (OCC)**]
d. [**Ortronics, Inc.**]
e. [**Panduit Corp**]
f. [**Siemon Co. (The)**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. For Communications Circuits: UL CCN DUXR; including UL 1863 and UL 467.
b. For Audio/Video, Data, and Signaling Circuits: UL CCN DUXR; including UL 1977 and UL 467.

5. Standard Features: This product type includes the frame only. Block inserts and related termination equipment are specified in communications cabling Sections.

C. UL DUXR - Patch Panel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Legrand AV Inc.; Legrand North America, LLC**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Ortronics, Inc.**]
f. [**Panduit Corp**]
g. [**Pass & Seymour; Legrand North America, LLC**]
h. [**Siemon Co. (The)**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]

b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Legrand AV Inc.; Legrand North America, LLC**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Ortronics, Inc.**]
f. [**Panduit Corp**]
g. [**Pass & Seymour; Legrand North America, LLC**]
h. [**Siemon Co. (The)**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. For Communications Circuits: UL CCN DUXR; including UL 1863 and UL 467.
   b. For Audio/Video, Data, and Signaling Circuits: UL CCN DUXR; including UL 1977 and UL 467.

5. Standard Features:

   a. Mounting: [**Equipment rack**][**Wall**].
   b. Style: [**Modular**][**Prepopulated 110 punch down**].
   c. EMI Compatibility: [**Shielded**][**Unshielded**].
   d. Configuration: [**Standard**][**High density**]; [**flat**][**angled**].
   e. Include provisions for labeling ports.
   f. Distribution Port Quantity: [**12**][**24**][**48**][**72**][**144**]<**Insert quantity**>.
   g. Cable Type: [**Cat. 5e**][**Cat. 6**][**Cat. 6a**][**Optical fiber**]<**Insert cable type**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Grounding and Bonding Conductors:

1. Communications Busbar Connections:

   a. TBC: Not smaller than [**1/0 AWG**][**3/0 AWG**]<**Insert wire size**> and no smaller than largest TBB.
   b. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
   c. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
   d. TEBC: Not smaller than [**2 AWG**]<**Insert wire size**> unless otherwise indicated on Drawings. Provide bolted connectors.
   e. UBC: Not smaller than [**6 AWG**]<**Insert wire size**> unless otherwise indicated on

Drawings. Provide bolted connectors.

f. Bonding Conductors to Structural Steel: Not smaller than [**6 AWG**]<**Insert wire size**> unless otherwise indicated on Drawings. Provide bolted clamp connectors.

2. Cable Tray Connections:

a. Cable Tray Equipment Grounding Conductor: [**8 AWG**][**6 AWG**][**4 AWG**].
b. Cable Tray Bonding Jumper: If not supplied by cable manufacturer, provide bonding jumper not smaller than [**10 AWG**][**6 AWG**] and not longer than **12 inch (300 mm)**. If jumper is wire, it must be terminated with lug having [**one hole and standard barrel for one crimp**][**two holes and long barrel for two crimps**]. If jumper is flexible braid, it must be terminated with [**one- or two-hole ferrule**][**one-hole ferrule**]. Attach with bonding screw or connector provided by cable tray manufacturer.

3. Underground Connections: Not smaller than [**2 AWG**]<**Insert wire size**>. Provide welded connectors, except bolted connectors may be used in handholes or manholes and as otherwise indicated on Drawings.

B. Grounding and Bonding Busbars:

1. PBB:

a. Dimensions: [**1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high)**]<**Insert dimensions**>.
b. Stand-Off Distance: [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**>.

2. SBB:

a. Dimensions: [**1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high)**]<**Insert dimensions**>.
b. Stand-Off Distance: [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**>.

C. Access Floor Signal Reference Grid:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing [**6 AWG**]<**Insert wire size**> bonding conductors in a grid pattern under the floor.

a. Install grid bonding conductors on **4 ft (1200 mm)** centers, so as to permit bonding of one structural pedestal for each access floor tile. Connect grid conductors together where they cross each other.
b. Bond SBBs in room to two or more bonding conductors of reference grid with TEBCs.
c. Bond equipment to nearest SBB and to reference grid with TEBCs.
d. Bond conduits and piping entering equipment room with TEBCs to nearest SBB and to grid conductor nearest entry into room.

D. Signal Reference Grid Wire Mesh:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing wire mesh [**in concrete floor slab**][**above ceiling**] with the following features:

a. Wire mesh, 10 AWG solid copper, **2 inch (50 mm)** spacing.
b. Wire mesh, 10 AWG solid copper, **3 inch (75 mm)** spacing.
c. Wire mesh, 10 AWG solid copper, **4 inch (100 mm)** spacing.
d. Wire mesh, 10 AWG solid copper, **6 inch (150 mm)** spacing.

e. Wire mesh, 10 AWG solid copper, **12 inch (300 mm)** spacing.
f. Wire mesh, 8 AWG solid copper, **4 inch (100 mm)** spacing.
g. Wire mesh, 8 AWG solid copper, **6 inch (150 mm)** spacing.
h. Wire mesh, 8 AWG solid copper, **8 inch (200 mm)** spacing.
i. Wire mesh, 8 AWG solid copper, **12 inch (300 mm)** spacing.
j. Wire mesh, 6 AWG solid copper, **4 inch (100 mm)** spacing.
k. Wire mesh, 6 AWG solid copper, **6 inch (150 mm)** spacing.
l. Wire mesh, 6 AWG solid copper, **8 inch (200 mm)** spacing.
m. Wire mesh, 6 AWG solid copper, **12 inch (300 mm)** spacing.
n. Wire mesh, 6 AWG solid copper, **24 inch (610 mm)** spacing.
o. Wire mesh, 4 AWG solid copper, **4 inch (100 mm)** spacing.
p. Wire mesh, 4 AWG solid copper, **6 inch (150 mm)** spacing.
q. Wire mesh, 4 AWG solid copper, **12 inch (300 mm)** spacing.
r. Wire mesh, 2 AWG solid copper, **4 inch (100 mm)** spacing.
s. Wire mesh, 2 AWG solid copper, **6 inch (150 mm)** spacing.
t. Wire mesh, 2 AWG solid copper, **12 inch (300 mm)** spacing.
u. Wire mesh, 2 AWG solid copper, **24 inch (610 mm)** spacing.

E. Signal Reference Grid Tape Mesh:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing tape mesh under floor finish with the following features:

a. Wire mesh, **2 inch (50 mm)** by **16 mil (0.4 mm)** solid copper, **12 inch (300 mm)** spacing.
b. Wire mesh, **2 inch (50 mm)** by **16 mil (0.4 mm)** solid copper, **24 inch (610 mm)** spacing.

3.3 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection[**and fire-alarm**] equipment[**, including raceways,**] must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than [**7.7 ft (2.3 m)**]<**Insert height**> above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1[**and IEEE C2**].

C. Color Coding Scheme for Communications Cable and Terminations: Comply with BICSI N1 and TIA-598.

D. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "COMMUNICATIONS."
2. "FIRE ALARM."
3. "SECURITY."
4. <**Insert name**>.

E. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

F. Locations of Underground Lines: Underground-line warning tape for communication, control wiring, and optical-fiber cable.

G. Communications Vaults, Manholes, Handholes, and Pull and Junction Boxes: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**vinyl wraparound labels**][**self-adhesive wraparound labels**][**snap-around labels**][**snap-around color-coding bands**][**self-adhesive vinyl tape**] to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.

H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use [**write-on tags**][**self-adhesive labels**] with conductor or cable designation, origin, and destination.

I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide [**heat-shrink preprinted tubes**][**self-adhesive labels**] with conductor designation.

J. Conductors to Be Extended in Future: Attach [**write-on tags**][**marker tape**] to conductors[**and list source**].

K. Auxiliary Electrical Systems Conductor Identification: [**Marker tape**][**Self-adhesive vinyl tape**] that is uniform and consistent with system used by manufacturer for factory-installed connections.

L. Equipment and Cabling Identification for Administrative Records and Labeling: Comply with TIA-606 requirements for [**Class 1**][**Class 2**][**Class 3**][**Class 4**] network administration.

M. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: [**Self-adhesive label**][**Baked-enamel signs**][**Metal-backed butyrate signs**][**Laminated acrylic or melamine plastic sign**].
3. Outdoor Equipment: [**Laminated acrylic or melamine sign**][**Stenciled legend 4 inch (100 mm) high**].
4. Equipment to Be Labeled:

    a. Racks, Frames, and Enclosures: Identify front and rear of each enclosure with self-adhesive labels[**containing equipment designation**].
    b. Patch Panels: [**Label individual rows in each rack, starting at top and working down, with self-adhesive labels.**][**Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.**]
    c. Communications cabinets.
    d. Access doors and panels for concealed communications items.
    e. Emergency system boxes and enclosures.
    f. Contactors.
    g. Remote-controlled switches, dimmer modules, and control devices.
    h. Monitoring and control equipment.
    i. Fire-alarm equipment.
    j. Security equipment.
    k. Life-safety communications equipment.
    l. <**Insert equipment**>.

N. Backbone Cables: Label each cable with a [**vinyl-wraparound label**][**snap-around label**][**self-adhesive wraparound label**] indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

O. Horizontal Cables: Label each cable with a [**vinyl-wraparound label**][**snap-around label**][**self-adhesive wraparound label**].

P. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Identify cover plate in accordance with TIA-606.

Q. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.4 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT/RACK HAS MULTIPLE POWER SOURCES."
2. <**Insert names and wording of warning signs or labels**>.

D. Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**].

E. Emergency Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**] with white legend on red background with minimum **3/8 inch (10 mm)** high letters for emergency instructions at equipment used for <**Insert emergency operations**>.

F. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.5 INSTALLATION OF FITTINGS FOR ENTRANCE FACILITY

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.
3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in entrance facility room or space as indicated on Drawings:

1. Equipment backing panel .

a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is

fire treated, ensure that fire-treatment stamp is visible after installation.

2. PBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 66-style or 110-style cross-connect frame .
10. Patch panel .

3.6 INSTALLATION OF FITTINGS FOR EQUIPMENT ROOM

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.
3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in entrance facility room or space as indicated on Drawings:

1. Equipment backing panel .

    a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is fire treated, ensure that fire-treatment stamp is visible after installation.

2. PBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 110-style cross-connect frame .
10. Patch panel .

3.7 INSTALLATION OF FITTINGS FOR TELECOMMUNICATIONS ROOMS

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.

3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in intermediate distribution frame room or space as indicated on Drawings:

1. Equipment backing panel .

   a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is fire treated, ensure that fire-treatment stamp is visible after installation.

2. SBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 110-style cross-connect frame .
10. Patch panel .

3.8 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Grounding of Communications: Bond PBB and SBBs to grounding electrode conductors at electrical power service entrance, and at electrical power derived systems serving communications equipment, using intersystem bonding termination device.

1. Structural Steel: Where structural steel of steel frame building is readily accessible within room or space, bond each SBB and PBB to vertical steel of building frame.

B. Comply with manufacturer's published instructions.

C. Reference Standards:

1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
2. Consult Architect for resolution of conflicting requirements.

D. Special Techniques:

1. Bonding of Busbars:

   a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers **12 inch (300 mm)** above finished floor unless otherwise indicated.
   b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

2. Bonding Conductors:

a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:

1) Use crimping tool and die specific to connector.
2) Pretwist conductor.
3) Apply antioxidant compound to bolted and compression connections.

c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
d. Install without splices.
e. Support conductors at not more than **36 inch (900 mm)** intervals.
f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-A or EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.

1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing and bond both ends of raceway to SBB.

3. Provide TBC and terminate ends to PBB and intersystem bonding [**termination device**][**busbar**] at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.
4. Busbar Interconnections: Bond SBBs to PBB with TBBs. If more than one TBB is installed, bond TBBs together with BBCs where required by TIA-607.
5. Communications Enclosures: Bond metallic enclosures of telecommunications equipment with UBCs to nearest SBB or PBB.
6. Equipment Racks: Bond metallic components of enclosures to RBB using UBCs. Provide [**top-mounted**][**vertically mounted**] RBB if not provided by enclosure or rack manufacturer. Bond RBB to SBB with TEBC. Power connection must comply with NFPA 70; equipment grounding conductor in power cord of cord- and plug-connected equipment must be considered supplemental to bonding requirements in this Section.
7. Shielded Cable: Bond shield of shielded cable to SBB in communications rooms and spaces. Comply with TIA-568.1 and TIA-568.2 when grounding shielded balanced twisted-pair cables.
8. Primary Protector: Bond to PBB with insulated bonding conductor.
9. Electrical Power Panelboards: Where electrical panelboards for communications equipment are located in same room or space, bond each ground bar of panelboard to SBB.
10. Cable Trays: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
11. Ladder Racks: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
12. Access Floors: Bond metal parts of access floors to SBB.
13. <**Insert connections for other equipment**>.

3.9 FIELD QUALITY CONTROL FOR BONDING OF COMMUNICATIONS

A. Administrant for Grounding and Bonding Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections

on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.

a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 mΩ.

1) If measured resistance from electrical service equipment to ground exceeds [**5 Ω**]<**Insert resistance**>, notify Architect and include recommendations to reduce resistance to ground.

b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 mΩ.

3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.

a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB[**and to SBBs**]. Maximum acceptable AC current level is 1 A.

E. Nonconforming Work:

1. Communications bonding will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

3.10 PROTECTION

A. After installation, protect communications equipment room fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 19 16

SECTION 26 05 19 16A - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backbone communications cables.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. See Section 270553 "Identification for Communications Systems" for communications equipment labels.
2. See Section 271513 "Communications Copper Horizontal Cabling" for Type CM, CMG, and CMX cabling.

D. Related Requirements:

1. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 270010 "Supplemental Requirements for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.3 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.4 DEFINITIONS

A. Cable Types:

1. FTP: Foil shielded twisted pair.
2. F/FTP: Bundle of FTP cables with overall foil shield.
3. F/UTP: Bundle of UTP cables with overall foil shield.
4. S/FTP: Bundle of FTP cables with overall braided shield.
5. S/UTP: Bundle of UTP cables with overall braided shield.
6. UTP: Unshielded twisted pair.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

1.5 SEQUENCING

A. Wet-work in spaces must be completely dry, and HVAC system must be operating and maintaining ambient temperature and humidity conditions within manufacturer's recommended limits, before delivering and installing cables and connecting materials.

1.6 ACTION SUBMITTALS

A. Product Data:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Shop Drawings:

1. Cable labeling schedules.
2. Cabling administration diagrams.
3. Wiring diagrams.
4. Cross-connect and patch panel details.
5. Twisted-pair cable testing plan.

C. Field quality-control reports.

D. Sustainable design submittals.

1. Backbone communications cable.

1.7 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Field Reports:

1. Factory Test Reports:

a. Backbone communications cable.

1.8 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: For communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Special Tools: For communications-, audio/video-, data-, and other signaling-circuit accessories.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted-pair cable for open and short circuits.

1.11 WARRANTY FOR COMMUNICATIONS COPPER BACKBONE CABLE ASSEMBLIES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed communications copper backbone cable assemblies perform in accordance with specified requirements and agrees to repair or replace cable assemblies that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 BACKBONE COMMUNICATIONS CABLES

A. Description: This category covers multiple conductor jacketed communications cable for telephone and other communications circuits for use in risers and plenums as described in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Certified Cable: UL CCN DUZX; including UL 444.
b. Verified Cable: UL CCN DVBI; including TIA-568.2.
c. Type CMP: NFPA 262.
d. Type CMR: UL 1666.
e. Limited Smoke: Marked "-LS" in accordance with UL 1685.
f. Halogen-Free: Marked "-HF" in accordance with UL Subject 2885.
g. Low Smoke and Halogen-Free: Marked "-LSHF" in accordance with IEC 61034-2.
h. Cable Heating Test: Marked "-LP" with current rating and temperature rating.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Sustainable Design Submittals: Prepare and submit documentation for the following:

    a. Product Data: For each conductor and cable indicating lead content of less than 300 parts per million.
    b. Environmental Product Declaration: For each product.
    c. Health Product Declaration: For each product.
    d. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
    e. Third-Party Certifications: For each product.
    f. Third-Party Certified Life Cycle Assessment: For each product.

3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
4. Factory Tests:

    a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
    b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate cable reels.
    c. Factory Tests and Inspections: Test and inspect cable on reels, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-568.2 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.
    d. Nonconforming Work:

        1) Cable reels that do not pass tests and inspections will be considered defective.

    e. Factory Test Reports: Prepare and submit factory test and inspection reports.

D. UL DUZX and DVBI - Type CMP, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CommScope, Inc**]
    b. [**Hitachi Cable America Inc.**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Molex Premise Networks**]
    f. [**Panduit Corp**]
    g. [**Prysmian Cables and Systems; Prysmian Group North America**]
    h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    i. [**West Penn Wire; brand of Belden, Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CommScope, Inc**]
    b. [**Hitachi Cable America Inc.**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell**

Incorporated]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

3. Product Marking: Type CMP; Category 3.
4. Options:

a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket:
[**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

E. UL DUZX and DVBI - Type CMP, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

F. UL DUZX and DVBI - Type CMP, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Product Marking: Type CMP; Category 6.
4. Options:

a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

G. UL DUZX and DVBI - Type CMP, Category 6A Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Molex Premise Networks**]
e. [**Panduit Corp**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Molex Premise Networks**]
e. [**Panduit Corp**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Product Marking: Type CMP; Category 6A.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

H. UL DUZX and DVBI - Type CMR, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. [**West Penn Wire; brand of Belden, Inc.**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]

k. [**West Penn Wire; brand of Belden, Inc.**]
l. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 3.
4. Options:

a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket:
[**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

I. UL DUZX and DVBI - Type CMR, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 5e.
4. Options:

a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

J. UL DUZX and DVBI - Type CMR, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Mohawk; a division of Belden Networking, Inc.**]
    g. [**Molex Premise Networks**]
    h. [**Panduit Corp**]
    i. [**Prysmian Cables and Systems; Prysmian Group North America**]
    j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    k. [**TE Connectivity Ltd.**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Mohawk; a division of Belden Networking, Inc.**]
    g. [**Molex Premise Networks**]
    h. [**Panduit Corp**]
    i. [**Prysmian Cables and Systems; Prysmian Group North America**]
    j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    k. [**TE Connectivity Ltd.**]
    l. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 6.
4. Options:

    a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
    b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
    c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

K. UL DUZX and DVBI - Type CMR, Category 6A Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]

d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 6A.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

L. UL DUZX and DVBI - Type CMR, Category 8 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 8.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**F/FTP**][**S/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

M. UL DUZX and DVBI - Type CMR-LS, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 3.
4. Options:

   a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
   c. Jacket:
   [**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

N. UL DUZX and DVBI - Type CMR-LS, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 5e.
4. Options:

   a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].

c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

O. UL DUZX and DVBI - Type CMR-LS, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 6.
4. Options:

   a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
   c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

P. UL DUZX and DVBI - Type CMR-LSHF, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 3.
4. Options:

   a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.

b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket:
[**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

Q. UL DUZX and DVBI - Type CMR-LSHF, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 5e.
4. Options:

a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

R. UL DUZX and DVBI - Type CMR-LSHF, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]

b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 6.
4. Options:

a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.2 COMMUNICATIONS-, AUDIO/VIDEO-, DATA-, AND OTHER SIGNALING-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for use in residential or commercial communications-station applications for connections to communications circuit as defined in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. <**Insert requirements**>.

2. Listing Criteria:

a. Communications-Circuit Accessories: UL CCN DUXR; including UL 1863.
b. Audio/Video-, Data-, and Other Signaling-Circuit Accessories: UL CCN DUXR; including UL 1977.
c. For Use in Air-Handling Spaces: UL 2043.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

D. UL DUXR - Connecting Block :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Panduit Corp**]

e. [**Siemon Co. (The)**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Panduit Corp**]
e. [**Siemon Co. (The)**]
f. <**Insert manufacturer's name**>

3. Options:

a. Configuration: [**110-style IDC for Category 5e**][**110-style IDC for Category 6**][**66-style IDC for Category 5e**].
b. Quantity of Terminations: Number of cables terminated on block, plus [**25**]<**Insert number**> percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. UL DUXR - Cross-Connect :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Panduit Corp**]
d. [**Siemon Co. (The)**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Panduit Corp**]
d. [**Siemon Co. (The)**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

3. Options:

a. Number of Terminals per Field: [**One**]<**Insert number**> for each conductor in assigned cables.
b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

F. UL DUXR - Patch Panel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. [**Panduit Corp**]
    f. [**Siemon Co. (The)**]
    g. [**TE Connectivity Ltd.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. [**Panduit Corp**]
    f. [**Siemon Co. (The)**]
    g. [**TE Connectivity Ltd.**]
    h. <**Insert manufacturer's name**>

3. General Characteristics:

    a. Universal T568A and T568B wiring labels.
    b. Labeling areas adjacent to conductors.
    c. Replaceable connectors.
    d. 24 or 48 ports.
    e. Construction: 16-gauge steel and mountable on **19 inch (483 mm)** equipment racks.

4. Options:

    a. Number of Jacks per Field: One for each four-pair [**twisted-pair cable indicated**][**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].
    b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

G. UL DUXR - 8P8C Plugs and Plug Assemblies :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

3. General Characteristics:

a. Male; 8P8C; color-coded modular telecommunications connector designed for termination of a single, four-pair, 100 Ω UTP or FTP cable.
b. Marked to indicate transmission performance.

4. Options:

a. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

H. UL DUXR - 8P8C Jacks and Jack Assemblies :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]

c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

3. General Characteristics:

a. Female; 8P8C; color-coded modular telecommunications connector designed for termination of a single, four-pair, 100 Ω UTP or FTP cable.
b. Designed to snap into patch panel or cover plate.
c. Marked to indicate transmission performance.

4. Options:

a. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

I. UL DUXR - Patch Cords :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. <**Insert manufacturer's name**>

3. General Characteristics:

a. Factory-made, four-pair cables; terminated with an 8P8C plug at each end.
b. Bend-relief-compliant boots and color-coded icons to ensure Category 6 performance.

c. Latch guards to protect against snagging.
d. Color-coded boots for circuit identification.

4. Options:

a. Length: [3 ft (0.9 m)][4 ft (1.2 m)]<**Insert length**>.
b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

J. Accessories:

1. Spare Parts: Furnish to Owner spare parts, for repairing cable assemblies and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

a. Connecting Blocks: [**One**]<**Insert number**> of each type.
b. Patch Panels: [**One**]<**Insert number**> of each type.
c. Plugs: [**Ten**]<**Insert number**> of each type.
d. Jacks: [**Ten**]<**Insert number**> of each type.

2. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to cable assemblies and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

a. <**Insert name of special tool**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following:

1. Cable Labeling Schedules: Submit electronic files[**using software and format requested by Owner**].
2. Cabling Administration Diagrams: Submit diagrams and supporting electronic files[**using software and format requested by Owner**].

a. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

3. Wiring Diagrams:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Cross-connects.
f. Patch panels.
g. Patch cords.

4. Cross-Connect and Patch Panel Details: Include mounting assemblies, elevations, and physical relationship between installed components.
5. Twisted-Pair Cable Testing Plan: Include list of cables to be tested, identification of tests to be

performed, pass/fail criteria, and copy of testing procedures (may be separate volume). Indicate Installer's required tests for warranty compliance.

3.2 SELECTION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Air-Handling Spaces:

1. Type CMP[**in listed plenum communications raceway**][**in listed cable routing assembly**].
2. Type CMR or Type CMP[**, Type CM, Type CMG, or Type CMX**] in metallic conduit installed in accordance with Rule 300.22 of NFPA 70.

B. Vertical Chases:

1. Type CMR.
2. Type CMP or Type CMR[**in listed plenum or riser communications raceway**][**in metallic conduit installed in accordance with Rule 300.22 of NFPA 70**].

3.3 INSTALLATION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation:

1. Communications Cable Assemblies: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N1.
2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

    a. Provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
    b. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

2. Drawings indicate general arrangement of pathways and fittings.
3. Wiring Methods:

    a. Raceway and Tray: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables, except in unfinished spaces.

        1) Install plenum cable in environmental air spaces, including plenum ceilings.
        2) Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

    b. Open-Cable: Route conductors and cables in accessible ceilings, walls, and floors where possible.

c. Within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

4. General Requirements for Cabling:

a. Install 110-style IDC termination hardware unless otherwise indicated.
b. Do not untwist twisted-pair cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
c. Terminate all conductors; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
d. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
e. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
f. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars and distribution spools.
g. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
h. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
i. In the communications equipment room, install **10 ft (3 m)** long service loop on each end of cable.
j. Pulling Cable: Monitor cable pull tensions.

5. Open-Cable Installation:

a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
b. Suspend twisted-pair cabling, not in a wireway or pathway, a minimum of **8 inch (200 mm)** above ceilings by cable supports not more than [**5 ft (1.5 m)**]<**Insert dimension**> apart.
c. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

6. Installation of Cable Routed Exposed under Raised Floors:

a. Install plenum-rated cable only.
b. Install cabling after the flooring system has been installed in raised floor areas.
c. Coil cable [**6 ft (1.8 m)**]<**Insert dimension**> long not less than [**12 inch (300 mm)**]<**Insert dimension**> in diameter below each feed point.

7. Group connecting hardware for cables into separate logical fields.
8. Separation from EMI Sources:

a. Comply with BICSI N1 for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
b. Separate open communications cables or cables in nonmetallic raceways from unshielded power conductors and electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum **5 inch (127 mm)**.
2) Power Rating between 2 and 5 kVA: Minimum **12 inch (300 mm)**.
3) Power Rating More Than 5 kVA: Minimum **24 inch (600 mm)**.

c. Separate communications cables in grounded metallic raceways from unshielded power lines or electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum **2-1/2 inch (64 mm)**.
2) Power Rating between 2 and 5 kVA: Minimum **6 inch (150 mm)**.
3) Power Rating More Than 5 kVA: Minimum **12 inch (300 mm)**.

d. Separate communications cables in grounded metallic raceways from power lines and electrical equipment located in grounded metallic conduits or enclosures as follows:

1) Power Rating Less Than 2 kVA: No minimum distance.
2) Power Rating between 2 and 5 kVA: Minimum **3 inch (76 mm)**.
3) Power Rating More Than 5 kVA: Minimum **6 inch (150 mm)**.

e. Separate communications cables from electrical motors and transformers rated 5 kVA or 5 HP and larger minimum **48 inch (1200 mm)**.
f. Separate communications cables from fluorescent luminaires minimum **5 inch (127 mm)**.

9. Identify system components, wiring, and cabling in accordance with TIA-606.

a. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
b. Paint and label colors for equipment identification must comply with TIA-606 for [**Class 2**][**Class 3**][**Class 4**] level of administration[**, including optional identification requirements of this standard**].

10. Cable and Wire Identification:

a. Label each cable within **4 inch (100 mm)** of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
b. Each wire connected to building-mounted devices is not required to be numbered at device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 ft (4.5 m)**.
d. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from panel or cabinet to building-mounted device, with name and number of particular device.
2) Label each unit and field within distribution racks and frames.

e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

11. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.
12. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets,[**backbone pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways,

and equipment grounding conductors.

13. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Entrance Facilities: Coordinate backbone cabling with Section 271100 "Communications Equipment Room Fittings" for cabinets, racks, and protectors and demarcation point provided by communications service provider.
2. Coordinate with Section 078413 "Penetration Firestopping" for sealing fire-rated penetrations.
3. Coordinate with Section 260533.16 "Boxes and Covers for Electrical Systems" for installation of outlet boxes and cover plates.
4. Coordinate with Section 270526 "Grounding and Bonding for Communications Systems" for grounding communications cabling and connectors.
5. Coordinate with Section 270528 "Pathways for Communications Systems" for installation of provisions for routing and terminating cable assemblies.
6. Coordinate with Section 270529 "Hangers and Supports for Communications Systems" for installation of cable supports.
7. Coordinate with Section 270536 "Cable Trays for Communications Systems" for installation of cable trays.
8. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

9. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

3.4 FIELD QUALITY CONTROL OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Visually inspect jacket materials for certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test

equipment manufacturer for channel or link test configuration.

D. Nonconforming Work:

1. Cable assemblies will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective cable assemblies and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 PROTECTION

A. After installation, protect cable assemblies and accessories from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 19 16A

SECTION 26 05 19 16B - COMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications coaxial cable.
2. CATV coaxial cable.
3. Coaxial cable hardware.
4. Grounding.
5. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. LAN: Local area network.

E. RCDD: Registered Communications Distribution Designer.

1.3 COAXIAL HORIZONTAL CABLING DESCRIPTION

A. Coaxial horizontal cabling system is to provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Communications coaxial cable.
2. CATV coaxial cable.
3. Coaxial cable hardware.
4. Grounding.
5. Identification products.

B. Product Data Submittals: For each product.

1. Nominal OD.
2. Minimum bending radius.
3. Maximum pulling tension.

C. Shop Drawings:

1. System Labeling Schedule:

a. Electronic copy of labeling schedules, in software and format selected by Owner.
b. Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

2. Cabling administration drawings and printouts.

D. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.
9. Samples: For telecommunications jacks and plugs, [**in specified finish, one for each type and configuration**][**and faceplates for color selection and evaluation of technical features**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**RCDD,**][**Installer,**]installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For coaxial cable, splices, and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**]<**Insert number**> of each type.
2. Jacks: [**Ten**]<**Insert number**> of each type.
3. Patch-Panel Units: [**One**]<**Insert number**> of each type.
4. Plugs: [**Ten**]<**Insert number**> of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[**and Cabling Administration Drawings**][**, Cabling Administration Drawings, and field testing program development**] by an [**RCDD**][**Technician**].
2. Installation Supervision: Installation is to be under the direct supervision of [**Technician**][**Level 2 Installer**], who is to be present at all times when Work of this Section is performed at Project site.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each coaxial cable [**on the reel**] for continuity.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system is to comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Communications Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated, Type CMP: Complying with UL 1685[**or Type CMP in listed plenum communications raceway**][**or Type CMP in listed cable routing assembly**].
2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed in accordance with NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. CATV Plenum Rated: Type CATVP [**installed in riser raceways or cable routing assemblies**], complying with NFPA 262.
2. CATV Cable: Type CATV[**, or CATVP or CATVR**][**installed in general purpose, riser, or plenum communications raceways or cable routing assemblies**] in fireproof riser shafts with firestops at each penetration.

2.3 COMMUNICATIONS COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for broadband data transmission.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 13, and with NFPA 70, "Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits" and "Communications Circuits" articles. Types are as follows:

1. RG-6/U: UL Type [**CMP**][**and**][**CL2P**].

    a. No. [**16**][**18**]<**Insert size**> AWG, solid, copper-covered steel conductor.
    b. Plenum rated.
    c. Gas-injected, foam-PE insulation.
    d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
    e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
    f. Jacketed with [**black**][**white**] PVC or PE.
    g. Suitable for indoor installations.

2. RG-11/U: UL Type [**CMP**][**and**][**CL2P**].

    a. No. [**14**]<**Insert size**> AWG, solid, copper-covered steel conductor.
    b. Plenum rated. Suitable for outdoor installations in ambient temperatures ranging from

minus 40 to plus 85 deg F (minus 40 to plus 30 deg C).

c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with sunlight-resistant, [**black**][**white**] PVC or PE.

3. RG-59/U: UL Type [**CMP**][**and**][**CL2P**].

a. No. [**20**]<**Insert size**> AWG, solid copper conductor.
b. Plenum rated.
c. Gas-injected, foam-PE insulation.
d. Single shielded with 100 percent aluminum shield and 40 percent aluminum braid.
e. PVC jacket.

2.4 CATV COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article. Types are as follows:

1. RG-6/U: UL Type CATVP.

a. No. 18 AWG, solid, copper-covered steel conductor.
b. Plenum rated.
c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with [**black**][**white**] PVC or PE.
g. Suitable for indoor installations.

2.5 COAXIAL CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Liebert; Vertiv Holdings Co.**]
3. [**Siemon Co. (The)**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Liebert; Vertiv Holdings Co.**]
3. [**Siemon Co. (The)**]
4. <**Insert manufacturer's name**>

D. Coaxial-Cable Connectors: Type BNC, 75 ohms.

E. Jacks and Jack Assemblies: Modular, color-coded, with female Type BNC connectors.

F. Patch Cords: Factory-made cables in [**36-inch (900-mm)**][**48-inch (1200-mm)**]<**Insert length**>lengths; terminated with a male Type BNC connector at each end.

G. Faceplates:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.
    a. Flush-mounted jacks, positioning the cord at a 90-degree angle from faceplate surface.
4. Legend:
    a. Factory labeled by silk-screening or engraving [**for**][**stainless steel**][**brass**]<**Insert description**>[**faceplates**].
    b. Machine printed, in the field, using adhesive-tape label.
    c. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate horizontal cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method, Raceways: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method, Concealed: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Comply with Section 271100 "Communications Equipment Room Fittings." Comply with requirements in Section 270528 "Pathways for Communications Systems" for installation of conduits and wireways.

B. Comply with Section 270528.29 "Hangers and Supports for Communications Systems."

C. Drawings indicate general arrangement of pathways and fittings.

D. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits [**3 inches (76 mm)**]<**Insert dimension**> above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with **96-inch (2440-mm)** dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF COAXIAL HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
2. Terminate all conductors; no cable is to contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps are not to be used for heating.
8. In the communications equipment room, install a **10-foot- (3-m-)** long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend coaxial cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than [**60 inches (1524 mm)**]<**Insert dimension**> apart.
3. Cable is not to be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet (1800 mm)**]<**Insert size**> long not less than [**12 inches (300 mm)**]<**Insert size**> in diameter below each feed point.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding **36 inches (915 mm)**.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **12 inches (300 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (610 mm)**.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (300 mm)**.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **3 inches (76 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 INSTALLATION OF GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260529 "Hangers and Supports for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, [**horizontal pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communications cabling, use a different color for jacks and plugs of each service.

E. Labels are to be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Visually inspect coaxial jacket materials for NRTL certification markings.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test coaxial horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.

E. Data for each measurement are to be documented. Data for submittals are to be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 26 05 19 16B

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Task	Specification	Specification Description
26 05 19 16	26 05 13 00	Medium-Voltage Cables
26 05 19 16	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 19 16	26 05 23 00	Control-Voltage Electrical Power Cables
26 05 19 16	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 23 00 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cable hardware.
6. Twin-axial data highway cable.
7. RS-232 cable.
8. RS-485 cable.
9. Control cable.
10. Control-circuit conductors.
11. Fire-alarm wire and cable.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cable hardware.
6. Twin-axial data highway cable.
7. RS-232 cable.
8. RS-485 cable.
9. Control cable.
10. Control-circuit conductors.
11. Fire-alarm wire and cable.

B. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.

7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: **60 inch (1520 mm)** or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 BACKBOARDS

A. Description: Plywood, [**fire-retardant treated,**]**3/4 by 48 by 96 inch (19 by 1220 by 2440 mm)**. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with [**flat**][**eggshell**][**black**]<**Insert color**>[**latex**][**alkyd**] paint. Comply with requirements in Section 099123 "Interior Painting."

1. Lead Content: Less than 300 parts per million.

2.3 CATEGORY 5e BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

E. Conductors: 100 ohm, No. 24 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

2.4 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]

11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

D. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

E. Conductors: 100 ohm, No. 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.5 CATEGORY 6a BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. **<Insert manufacturer's name>**

D. Standard: Comply with TIA-568-C.2 for Category 6a cables.

E. Conductors: 100 ohm, No. 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.6 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]

18. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]
18. **<Insert manufacturer's name>**

D. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of [**Category 5e**][**Category 6**][**Category 6a**][**Category 7**].
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables must be terminated with connecting hardware of same category or higher.

E. Source Limitations: [**Obtain balanced twisted pair cable hardware from single source from single manufacturer**][**Obtain balanced twisted pair cable hardware from same manufacturer as balanced twisted pair cable, from single source**].

F. Connecting Blocks: [**110-style IDC for Category 5e**][**110-style IDC for Category 6**][**66-style IDC for Category 5e**]. Provide blocks for the number of cables terminated on the block, plus [**25**]**<Insert number>** percent spare, integral with connector bodies, including plugs and jacks where indicated.

G. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: [**One**]**<Insert number>** for each conductor in assigned cables.

H. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on **19 inch (483 mm)** equipment racks.

3. Number of Jacks per Field: One for each four-pair [**cable indicated**][**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].

I. Patch Cords: Factory-made, four-pair cables in [**36 inch (900 mm)**][**48 inch (1200 mm)**]<**Insert length**>lengths; terminated with an eight-position modular plug at each end.

1. Patch cords must have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords must have latch guards to protect against snagging.
2. Patch cords must have color-coded boots for circuit identification.

J. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

K. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:

    a. Category 5e, unshielded balanced twisted pair cable must comply with IEC 60603-7-2.
    b. Category 5e, shielded balanced twisted pair cable must comply with IEC 60603-7-3.
    c. Category 6, unshielded balanced twisted pair cable must comply with IEC 60603-7-4.
    d. Category 6, shielded balanced twisted pair cable must comply with IEC 60603-7.5.
    e. Category 6a, unshielded balanced twisted pair cable must comply with IEC 60603-7-41.
    f. Category 6a, shielded balanced twisted pair cable must comply with IEC 60603-7.51.

4. Marked to indicate transmission performance.

L. Faceplate:

1. [**Two**][**Four**][**Six**] port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. [**Eight**][**10**][**12**] port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
4. Metal Faceplate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

M. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 TWIN-AXIAL DATA HIGHWAY CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, <**Insert number**> pairs, [**No. 20**][**No. 22**][**No. 24**] AWG, stranded [**(7x28)**][**(7x30)**][**(7x32)**] tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1685.
7. Lead Content: Less than 300 parts per million.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, <**Insert number**> pairs, [**No. 20**][**No. 22**][**No. 24**] AWG, stranded [**(7x28)**][**(7x30)**][**(7x32)**] tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.
7. Lead Content: Less than 300 parts per million.

2.8 RS-232 CABLE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Wire & Cable Inc.**]
2. [**Belden Inc.**]
3. [**General Cable; Prysmian Group North America**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Wire & Cable Inc.**]
2. [**Belden Inc.**]
3. [**General Cable; Prysmian Group North America**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. PVC-Jacketed, TIA 232-F:

1. [**Three**][**Nine**], No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Lead Content: Less than 300 parts per million.
3. Polypropylene insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. PVC jacket.

6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. NFPA 70 Type: Type CM.
8. Flame Resistance: Comply with UL 1581.

D. Plenum-Type, TIA 232-F:

1. [**Three**][**Nine**], No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Lead Content: Less than 300 parts per million.
3. PE insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. Fluorinated ethylene propylene jacket.
6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. Flame Resistance: Comply with NFPA 262.

2.9 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, [**one pair**][**two pairs**], twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, [**one pair**][**two pairs**], No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.
6. Lead Content: Less than 300 parts per million.

2.10 CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. [**One**][**Multi-**]pair, twisted, [**No. 16 AWG, stranded (19x29)**][**No. 18 AWG, stranded (19x30)**] tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. [**One**][**Multi-**]pair, twisted, [**No. 16 AWG, stranded (19x29)**][**No. 18 AWG, stranded (19x30)**] tinned-copper conductors.
2. PVC insulation.
3. Unshielded.

4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.
6. Lead Content: Less than 300 parts per million.

2.11 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Encore Wire Corporation**]
2. [**General Cable; Prysmian Group North America**]
3. [**Service Wire Co.**]
4. [**Southwire Company, LLC**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Encore Wire Corporation**]
2. [**General Cable; Prysmian Group North America**]
3. [**Service Wire Co.**]
4. [**Southwire Company, LLC**]
5. <**Insert manufacturer's name**>

C. Class 1 Control Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type THW, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**Type TC, complying with UL 1277 in raceway**][**Type MC, complying with UL 1569**].

D. Class 2 Control Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**power-limited cable, concealed in building finishes**][**power-limited tray cable, in cable tray**].

E. Class 3 Remote-Control and Signal Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**power-limited cable, concealed in building finishes**][**power-limited tray cable, in cable tray**][**Type TW or Type TF, complying with UL 83, in raceway**].

F. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.
2. <**Insert list of critical circuits that require CI cable**>.

2.12 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Wire & Cable Inc.**]
2. [**CommScope, Inc**]
3. [**Comtran Corporation**]

4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Radix Wire**]
7. [**Rockbestos-Suprenant Cable Corp.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. [**West Penn Wire; brand of Belden, Inc.**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Wire & Cable Inc.**]
2. [**CommScope, Inc**]
3. [**Comtran Corporation**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Radix Wire**]
7. [**Rockbestos-Suprenant Cable Corp.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. [**West Penn Wire; brand of Belden, Inc.**]
10. <**Insert manufacturer's name**>

C. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

1. Lead Content: Less than 300 parts per million.

D. Signaling Line Circuits: Twisted, shielded pair, [**not less than**][**No. 18 AWG**]<**Insert wire size**>[**size as recommended by system manufacturer**].

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

E. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor[**with outer jacket**] with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or modified in this Section.

B. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems" for raceway selection and installation requirements for wireways as supplemented or modified in this Section.

C. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for raceway selection and installation requirements for boxes as supplemented or modified in this Section.

1. Outlet boxes must be no smaller than **2 inch (50 mm)** wide, **3 inch (75 mm)** high, and **2-1/2 inch (64 mm)** deep.
2. Outlet boxes for cables must be no smaller than **4 inch (102 mm)** square by [**1-1/2 inch (38 mm)**][**2-1/8 inch (53 mm)**] deep with extension ring sized to bring edge of ring to within **1/8 inch (3.1 mm)** of the finished wall surface.
3. Flexible metal conduit must not be used.

D. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows if possible.

F. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits [**3 inch (75 mm)**]<**Insert dimension**> above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with **96 inch (2440 mm)** dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than **1/2 inch (12 mm)** at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of **8 inch (200 mm)** above ceilings by cable supports not more than [**30 inch (760 mm)**]<**Insert dimension**> apart.
3. Cable must not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of [72 inch (1830 mm)]<**Insert dimension**> of cable in a coil not less than [12 inch (305 mm)]<**Insert dimension**> in diameter.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **5 inch (127 mm)**.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **12 inch (305 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **24 inch (600 mm)**.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **2-1/2 inch (64 mm)**.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **6 inch (150 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **12 inch (305 mm)**.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **3 inch (75 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **6 inch (150 mm)**.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of **48 inch (1200 mm)**.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inch (127 mm)**.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; [**No 14 AWG**]<**Insert wire size**>.
2. Class 2 low-energy, remote-control, and signal circuits; [**No. 16 AWG**]<**Insert wire size**>.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; [**No 12 AWG**]<**Insert wire size**>.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers must use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 05 23 00

Task	Specification	Specification Description
26 05 23 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 26 00 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connectors.
7. Grounding and bonding busbars.
8. Signal reference grids.
9. Grounding (earthing) electrodes.
10. Grounding electrode enclosures.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 264113 "Lightning Protection for Structures" specifies bonding of lightning protection grounding electrodes to facility grounding electrodes.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
6. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for identification and grounding and bonding of communications equipment, raceways, boxes, and cable trays.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for

submitted product.

B. Shop Drawings: Prepare and submit the following:

1. Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:

a. Grounding electrode access enclosures.
b. Grounding electrodes.
c. Grounding arrangements and connections for separately derived systems.
d. <**Insert items**>.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

D. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:

a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:

1) Grounding electrode access enclosures.
2) Grounding electrodes.
3) Grounding arrangements and connections for separately derived systems.
4) <**Insert items**>.

b. Instructions for periodic testing and inspection of grounding features at [**test wells**][**ring electrodes**][**grounding connections for separately derived systems**]<**Insert locations**> based on [**NETA MTS**][**NFPA 70B**]<**Insert reference**>.

1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
2) Include recommended testing intervals.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical

tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems, evaluate tests, test equipment, test results, and power system performance, recommend actions to maintain or improve system performance, and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.6 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Soil Resistivity: Grounding (earthing) Work on the Project must account for soil resistivity conditions specified in Section 018116 "Facility Environmental Requirements."

B. Electrical and ICT Equipment Grounding (Earthing): Do not exceed [**25 Ω**][**10 Ω**]<**Insert resistance value**> resistance to ground (earth).

1. Contact Architect for resolution if 25 Ω specified resistance to ground (earth) is not attained after complying with prescriptive requirements in Article 250 of NFPA 70.
2. Contact Architect for resolution if [**10 Ω**]<**Insert resistance value**> specified resistance to ground (earth) is not attained after second attempt to increase effectiveness of grounding (earthing) electrode.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <**Insert additional performance requirements for the Project**>.

2.2 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. Standard Features: 600 V, [**THHN/THWN-2**][**or**][**THWN-2**], [**copper**][**or**][**tinned-copper**] wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. Standard Features: 600 V, [**THHN/THWN-2**][**or**][**THWN-2**], [**copper**][**or**][**tinned-copper**] wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ERICO; brand of nVent Electrical plc**]
   b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ERICO; brand of nVent Electrical plc**]
   b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Complying with one or more of the following:

   a. Soft or Annealed Copper Wire: ASTM B3.
   b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
   c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
   d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

4. Sustainable Design Features:

   a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER - Armored Grounding Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**LS Cable & System USA; subsidiary of LS Corp.**]
   b. [**Southwire Company, LLC**]
   c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   d. [**Viakon; brand of Conductores Monterrey S.A. de C.V.; a subsidiary of Xignux**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**LS Cable & System USA; subsidiary of LS Corp.**]
    b. [**Southwire Company, LLC**]
    c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    d. [**Viakon; brand of Conductores Monterrey S.A. de C.V.; a subsidiary of Xignux**]
    e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

4. Standard Features: Single corrosion-resistant copper, aluminum, or copper-clad aluminum conductor within helically formed steel armor.
5. Sustainable Design Features:

    a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
    b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDSH - Protector Grounding Conductor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features:

a. Conductors intended to be used for grounding primary protector or metallic members of cable sheath in accordance with Chapters 7 and 8 of NFPA 70.
b. Color: [**Light olive gray**][**or**][**green**].

5. Sustainable Design Features:

a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.3 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.

B. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
    c. [**Arlington Industries, Inc.**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    f. [**ERICO; brand of nVent Electrical plc**]
    g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
    h. [**Greaves Corp.; Essex Products Group, Inc.**]
    i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
    k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    l. [**Panduit Corp**]
    m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

    a. Two pieces with [**zinc-plated**][**stainless steel**] bolts.
    b. Clamp Material: [**Silicon bronze**][**Die-cast zinc alloy**][**Aluminum**][**Brass**][**Tinned brass**].
    c. Listed for outdoor use.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

a. Clamp Material: [**Aluminum**][**Brass**][**Tinned brass**].
b. Listed for outdoor use.

6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**ERICO; brand of nVent Electrical plc**]
   d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   e. [**Panduit Corp**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**ERICO; brand of nVent Electrical plc**]
   d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   e. [**Panduit Corp**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

   a. Clamp Material: [**Aluminum**][**Copper**][**Tinned copper**][**Galvanized steel**].
   b. Listed for outdoor use.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced

(extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDER - Beam Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anderson; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Panduit Corp**]
   d. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Anderson; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Panduit Corp**]
   d. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL KDER - Exothermically Welded Connection :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**ALLTEC LLC**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**ALLTEC LLC**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL KDER - Raised-Floor Signal Reference Grid Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**ERICO; brand of nVent Electrical plc**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**ERICO; brand of nVent Electrical plc**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, stamped-steel terminal with hex head screw.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.4 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. UL KDER - Bonding Bushing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Arlington Industries, Inc.**]
    c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Arlington Industries, Inc.**]
    c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Threaded bushing with insulated throat.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Grounding Bushing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Threaded bushing with insulated throat and mechanical-type wire terminal.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 GROUNDING AND BONDING HUBS

A. UL KDER - Grounding and Bonding Hub :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Arlington Industries, Inc.**]
    c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Greaves Corp.; Essex Products Group, Inc.**]
    f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    g. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Arlington Industries, Inc.**]
    c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Greaves Corp.; Essex Products Group, Inc.**]
    f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    g. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Insulated, gasketed, watertight hub with mechanical-type wire terminal.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.6 GROUNDING AND BONDING CONNECTORS

A. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Chatsworth Products, Inc.**]
c. [**Greaves Corp.; Essex Products Group, Inc.**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Chatsworth Products, Inc.**]
c. [**Greaves Corp.; Essex Products Group, Inc.**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, [**aluminum**][**copper rated for direct burial**] terminal with set screw.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
c. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
c. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on **5/8 or 1 inch (16 or 25 mm)** centers for two-bolt connection to busbar.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Panduit Corp**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Panduit Corp**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**aIIG Fabrication (formerly ALT)**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**aIIG Fabrication (formerly ALT)**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.

    a. [**Copper**][**Copper alloy**][**Tinned copper**], C and H shaped.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**allG Fabrication (formerly ALT)**]
    c. [**ERICO; brand of nVent Electrical plc**]
    d. [**Greaves Corp.; Essex Products Group, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**allG Fabrication (formerly ALT)**]
    c. [**ERICO; brand of nVent Electrical plc**]
    d. [**Greaves Corp.; Essex Products Group, Inc.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened.

a. [**Copper**][**Copper alloy**][**Tinned copper**].

6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL KDER - Signal Reference Grid Grounding and Bonding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**ERICO; brand of nVent Electrical plc**]
e. [**Harger Lightning & Grounding; business of Harger, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**ERICO; brand of nVent Electrical plc**]
e. [**Harger Lightning & Grounding; business of Harger, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.7 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.

B. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   b. [**Madison Electric Products; business of Southwire Company, LLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   b. [**Madison Electric Products; business of Southwire Company, LLC**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features: Zinc-alloy one-piece construction; six terminating points; gangable.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced

(extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features: [**Zinc-alloy**][**Copper**] body and polycarbonate cover; four terminating points.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.8 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.

B. UL KDER - Equipment Room Grounding and Bonding Busbar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**allG Fabrication (formerly ALT)**]
    b. [**Chatsworth Products, Inc.**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**ERICO; brand of nVent Electrical plc**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. [**Hoffman; brand of nVent Electrical plc**]
    h. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
    i. [**Panduit Corp**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**allG Fabrication (formerly ALT)**]
    b. [**Chatsworth Products, Inc.**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**ERICO; brand of nVent Electrical plc**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. [**Hoffman; brand of nVent Electrical plc**]
    h. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
    i. [**Panduit Corp**]
    j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features:

    a. Bus: Rectangular bar of annealed copper.
    b. Mounting Stand-Off Insulators: Lexan or PVC.

        1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability

report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (lgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

7. Other Available Features Required by the Project:

a. Dimensions: [**1/4 by 4 inch (6.3 by 100 mm)**]<**Insert dimensions**> in cross section; length as indicated on the Drawings.

b. Predrilled Hole Pattern: [**Complying with BICSI N3 and TIA-607**][**9/32 inch (7.14 mm) holes spaced 1-1/8 inch (28 mm) apart**][**Suitable for installing specified grounding and bonding connectors**].

c. Mounting Hardware: Stand-off brackets that provide [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**> clearance to access rear of bus. Brackets and bolts must be stainless steel.

C. UL KDER - Rack and Cabinet Bonding Busbar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Chatsworth Products, Inc.**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
d. [**Hoffman; brand of nVent Electrical plc**]
e. [**Panduit Corp**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Chatsworth Products, Inc.**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
d. [**Hoffman; brand of nVent Electrical plc**]
e. [**Panduit Corp**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features:

   a. Bus: Rectangular bar of hard-drawn solid copper.
   b. Horizontal Mounting Dimensions: Designed for mounting in [**19 inch (483 mm)**][**23 inch (584 mm)**] wide equipment racks or cabinets.
   c. Vertical Mounting Dimensions: Designed for mounting in [**72 inch (1827 mm)**][**36 inch (914 mm)**] high equipment racks or cabinets.
   d. Predrilled Hole Pattern: Accepts connectors for grounding and bonding conductor sizes 14 AWG to 2/0 AWG.
   e. Mounting Hardware: Stainless steel or copper-plated, for attachment to rack.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.9 SIGNAL REFERENCE GRIDS

A. Description: Means for providing low-impedance path to ground over a large area, approximating an equipotential plan, while simultaneously mitigating large current spikes from faults or lightning.

B. UL KDER - Mesh-Type Signal Reference Grid :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Conductive metal wire mesh for field-fabrication of grid.

    a. Wire Size: [**8 AWG**][**6 AWG**][**4 AWG**][**2 AWG**].
    b. Wire Material: [**Copper**][**Copper-clad steel**].
    c. Spacing: [**4 inch (102 mm)**][**8 inch (203 mm)**][**12 inch (305 mm)**][**24 inch (610 mm)**].
    d. Welded or brazed intersections.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Tape-Type Signal Reference Grid :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    b. [**ERICO; brand of nVent Electrical plc**]
    c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    b. [**ERICO; brand of nVent Electrical plc**]
    c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Conductive copper tape for field-fabrication of grid.

   a. Copper Tape Dimensions: [**16 mil (0.4 mm) (26 ga.) thick by 2 inch (51 mm) wide**][**40 mil (1 mm) (18 ga.) thick by 1.6 inch (40 mm) wide**]<**Insert dimensions**>.
   b. Spacing: [**24 inch (610 mm)**]<**Insert dimension**>.
   c. Welded or brazed fittings for intersections.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.10 GROUNDING (EARTHING) ELECTRODES

A. UL KDER - Rod Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**allG Fabrication (formerly ALT)**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**ERICO; brand of nVent Electrical plc**]
   e. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**allG Fabrication (formerly ALT)**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**ERICO; brand of nVent Electrical plc**]
   e. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch by 10 ft (19 mm by 3 m)**][**5/8 inch by 8 ft (16 mm by 2.4 m)**].
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL KDER - Chemically Charged Rod Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**aIIG Fabrication (formerly ALT)**]
b. [**ALLTEC LLC**]
c. [**ERICO; brand of nVent Electrical plc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**aIIG Fabrication (formerly ALT)**]
b. [**ALLTEC LLC**]
c. [**ERICO; brand of nVent Electrical plc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Copper tube, straight or L-shaped, charged electrode enhancement material.

a. Termination: Factory-attached 4/0 AWG bare conductor at least **48 inch (1200 mm)** long.
b. Backfill Material: Electrode manufacturer's recommended material.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

7. Other Available Features Required by the Project:

    a. Electrode Enhancement Material: [**Nonhazardous electrolytic chemical salts**]<**Insert enhancement material**>.

C. UL KDER - Plate Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ALLTEC LLC**]
    b. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ALLTEC LLC**]
    b. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: **1/4 inch (6 mm)** thick, hot-dip galvanized.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.11 GROUNDING ELECTRODE ENCLOSURES

A. Description: Enclosures designed to protect grounding electrodes from damage while providing access for inspection and testing of the grounding system.

B. Grounding Electrode Access Well Enclosure :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ERICO; brand of nVent Electrical plc**]
    b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    c. [**Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ERICO; brand of nVent Electrical plc**]
    b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    c. [**Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Standard Features:

    a. Well Material: [**Concrete**][**HDPE**][**Schedule 40 PVC**].
    b. Cover Material: [**Cast iron**][**Concrete**][**HDPE**][**Plastic**][**Steel**].
    c. Cover Strength: [**Sidewalk or turf use**][**Driveway use**]<**Insert rating**>.

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Material Reuse: Product is salvaged, refurbished, or reused.
    c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.

f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Round:

1) Nominal Diameter: [**8 inch (200 mm)**][**9 inch (230 mm)**][**10 inch (250 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**]<**Insert dimension**>.
2) Nominal Height: [**10 inch (250 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (760 mm)**][**36 inch (910 mm)**][**48 inch (1220 mm)**]<**Insert dimension**>.
3) Slotted sides for installation after grounding connections made.

b. Rectangular:

1) Nominal Width: [**2 inch (50 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**][**17 inch (430 mm)**][**36 inch (910 mm)**]<**Insert dimension**>.
2) Nominal Length: [**10 inch (250 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**][**17 inch (430 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**36 inch (910 mm)**][**42 inch (1070 mm)**]<**Insert dimension**>.
3) Nominal Height: [**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (760 mm)**]<**Insert dimension**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

A. Grounding and Bonding Conductors:

1. Provide solid conductor for [**8 AWG**]<**Insert wire size**> and smaller, and stranded conductors for [**6 AWG**]<**Insert wire size**> and larger unless otherwise indicated.
2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, **1/4 inch (6 mm)** in diameter.
4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; **1-5/8 inch (41 mm)** wide and **1/16 inch (1.6 mm)** thick.

6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Underground Grounding Conductors: Install bare [**tinned-**]copper conductor, [**2/0 AWG**]<**Insert wire size**> minimum.

B. Grounding and Bonding Connectors:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.

D. Substation Signal Reference Grid:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with IEEE C2.

a. Install [**8 AWG**][**6 AWG**]<**Insert wire size from fault calculation**> bonding conductors below grade in a grid pattern on 2 ft (600 mm) centers. Bond grid conductors with exothermic welds where they cross each other.
b. Grid must fill entire area inside equipment yard fence, and extend minimum 6.5 ft (2 m) outside fence, so someone walking or running outside yard may not touch fence or open gate without first stepping inside grid.
c. Bond each metal fence post and gate post to at least two grid conductors.
d. Inside grid, bond equipment reinforcing steel inside bases and sidewalks to at least two grid conductors.
e. Bond underground metal pipe and conduit passing under grid to nearest grid conductor at both ends.

E. Signal Reference Grid Tape Mesh:

1. Install tape mesh under floor finish with the following features:

a. Tape mesh, 2 inch (50 mm) by 16 mil (0.4 mm) solid copper, [12 inch (300 mm)][24 inch (610 mm)] spacing.

3.3 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.4 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR TOWERS AND ANTENNAS

A. Special Techniques:

1. Ring Electrode: Buried at least 30 inch (760 mm) below grade and at least 24 inch (610 mm) from base of tower or mounting.
2. Bond each tower base and metallic frame of dish to ring electrode, buried at least 18 inch (460 mm) below grade.
3. Bond ring electrode and antenna bonding conductors to equipment room PBB or SBB, buried at least 30 inch (760 mm) below grade.

4. Bond metal fences located within **6 ft (1.8 m)** of towers and antennas to ring electrode, buried at least **18 inch (460 mm)** below grade.
5. Special Requirements for Roof-Mounted Towers:

    a. Roof Ring: Meet requirements for ring electrode except conductors must comply with NFPA 780.
    b. Bond tower base footings steel, SBB in equipment room, and antenna support guys to roof ring.
    c. Connect roof ring to perimeter conductors of lightning protection system.

6. Special Requirements for Waveguides and Coaxial Cable:

    a. Bond cable shields at point of entry into building to nearest SBB and to cable entrance plate, using 2 AWG bonding conductors.
    b. Bond coaxial cable surge arrester to ring electrode or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.5 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Work in ITE Rooms: NFPA 75.
7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
12. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:

    a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
    b. Underground Grounding Conductors:

        1) Bury at least **30 inch (750 mm)** below grade.
        2) Duct-Bank Grounding Conductor: Bury **12 inch (300 mm)** above duct bank when indicated as part of duct-bank installation.

2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or

electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.

g. Grounding and Bonding for Piping:

1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [**tinned**]bonding jumper to bond across flexible duct connections to achieve continuity.
i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than **60 ft (18 m)** apart.

3. Grounding and Bonding Busbars:

a. Install busbar horizontally, on insulated spacers **2 inch (50 mm)** minimum from wall, **6 inch (150 mm)** above finished floor unless otherwise indicated.
b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

4. Electrodes:

a. Ground Rods: Drive rods until tops are **2 inch (50 mm)** below finished floor or final grade unless otherwise indicated.

1) Interconnect ground rods with grounding electrode conductor below grade and as

otherwise indicated. Make connections without exposing steel or damaging coating if any.

2) Use exothermic welds for below-grade connections.

b. For grounding electrode system, install at least [**three**]<**Insert number**> rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.

c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least **12 inch (300 mm)** deep, with cover.

1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

d. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each [**steel column**][**indicated item**], extending around perimeter of [**building**][**area or item indicated**].

1) Install tinned-copper conductor not less than [**2/0 AWG**]<**Insert wire size**> for ring electrode and for taps to building steel.

2) Bury ring electrode not less than [**24 inch (600 mm)**]<**Insert dimension**> from building's foundation.

e. Concrete-Encased Electrode (Ufer Ground):

1) Fabricate in accordance with NFPA 70; use minimum of [**20 ft (6 m)**]<**Insert dimension**> of bare copper conductor not smaller than [**4 AWG**]<**Insert wire size**>.

a) If concrete foundation is less than [**20 ft (6 m)**]<**Insert dimension**> long, coil excess conductor within base of foundation.

b) Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

2) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least **20 ft (6.0 m)** long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.

5. Grounding at Service:

a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.

6. Grounding Separately Derived Systems:

a. Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode must be connected to equipment grounding conductor and to frame of generator.

7. Grounding Underground Distribution System Components:

a. Duct-Bank Grounding Conductor: Bury **12 inch (300 mm)** above duct bank when indicated as part of duct-bank installation.

b. Comply with IEEE C2 grounding requirements.
c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so **4 inch (100 mm)** will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from **2 inch (50 mm)** above to **6 inch (150 mm)** below concrete. Seal floor opening with waterproof, nonshrink grout.
d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than **6 inch (150 mm)** from foundation.

8. Equipment Grounding and Bonding:

a. Install insulated equipment grounding conductors with feeders and branch circuits.
b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1) Feeders and branch circuits.
2) Lighting circuits.
3) Receptacle circuits.
4) Single-phase motor and appliance branch circuits.
5) Three-phase motor and appliance branch circuits.
6) Flexible raceway runs.
7) Armored and metal-clad cable runs.
8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9) X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
e. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
f. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway

and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

g. Poles Supporting Outdoor Lighting Fixtures: Bond insulated equipment grounding conductor to equipment grounding terminal inside pole base.

h. Metallic Fences: Comply with requirements of IEEE C2.

1) Grounding Conductor: Bare[**, tinned**] copper, not less than [**8 AWG**]<**Insert wire size**>.

2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.

3) Barbed Wire: Strands must be bonded to grounding conductor.

9. Fence Grounding:

a. Grounding Method: At each grounding location, drive grounding rod vertically until top is **6 inch (150 mm)** below finished grade. Connect rod to fence with 6 AWG conductor. Connect conductor to each fence component at grounding location.

b. Fences greater than **100 ft (30 m)** of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of [**1500 ft (450 m)**]<**Insert lesser distance if grounding resistance is high**>.

c. Fences within **100 ft (30 m)** of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of [**750 ft (225 m)**]<**Insert lesser distance if grounding resistance is high**>.

1) Gates and Other Fence Openings: Ground fence on each side of opening.

a) Bond metal gates to gate posts by connecting bonding jumper between gate post and gate frame.

b) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use 2 AWG wire and bury it at least **18 inch (460 mm)** below finished grade.

d. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of power line crossing and at maximum distance of **150 ft (45 m)** on each side of crossing.

e. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground fence and bond fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.6 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[**, at ground test wells**][**, and at individual ground rods**]. Make tests at ground rods before conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
    c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

F. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:

    a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: [**10 Ω**]<**Insert ohms**>.
    b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: [**5 Ω**]<**Insert ohms**>.
    c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: [**3 Ω**]<**Insert ohms**>.
    d. Power Distribution Units or Panelboards Serving Electronic Equipment: [**1 Ω**][**3 Ω**]<**Insert ohms**>.
    e. Substations and Pad-Mounted Equipment: [**5 Ω**]<**Insert ohms**>.
    f. Manhole Grounds: [**10 Ω**]<**Insert ohms**>.
    g. <**Insert application and maximum ground-resistance**>.

3.7 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 26 00

Task	Specification	Specification Description
26 05 26 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 43 00 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type HDPE and Type EPEC duct raceways and fittings.
4. Type ERMC duct raceways, elbows, couplings, and nipples.
5. Type FMC duct raceways.
6. Type FMT duct raceways.
7. Type IMC duct raceways.
8. Type LFMC duct raceways.
9. Type LFNC duct raceways.
10. Type PVC duct raceways and fittings.
11. Type RTRC duct raceways and fittings.
12. Fittings for conduit, tubing, and cable.
13. Joint compounds.
14. Solvent cements.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies firestopping referenced by this Section.
5. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
6. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
7. Section 260543 "Underground Ducts and Raceways for Electrical Systems" specifies exterior duct banks, manholes, and underground utility construction.
8. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.
9. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for installation of conduits for communications cabling.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.

4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERMC: Electrical rigid metal conduit.
10. ERMC-A: Aluminum electrical rigid metal conduit.
11. ERMC-S: Steel electrical rigid metal conduit.
12. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERMC-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

B. Definitions:

1. Conduit: A structure containing one or more duct raceways.
2. Direct Buried: Installed underground without encasement in concrete or other protective material.
3. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
4. Duct Raceway: A single enclosed raceway for conductors or cable.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. ERMC-S-PVC Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by ERMC-S-PVC manufacturer prior to starting installation.

E. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <**Insert additional performance requirements for the Project**>.

2.2 TYPE EMT DUCT RACEWAYS AND ELBOWS

A. UL FJMX - Aluminum Electrical Metal Tubing (EMT-A) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
   b. [**Patriot Aluminum Products, LLC**]
   c. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
   b. [**Patriot Aluminum Products, LLC**]
   c. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN FJMX; including UL 797A.

4. Standard Features:

   a. Material: Aluminum.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL FJMX - Stainless Steel Electrical Metal Tubing (EMT-SS) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Calconduit; Atkore International**]
b. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Calconduit; Atkore International**]
b. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FJMX; including UL 797A.

4. Standard Features:

a. Material: Stainless steel.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Emerson Electric Co., Automation Solutions**]
d. [**Picoma; Zekelman Industries**]
e. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Emerson Electric Co., Automation Solutions**]
d. [**Picoma; Zekelman Industries**]
e. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FJMX; including UL 797.

4. Standard Features:

a. Material: Steel.
b. Exterior Coating: [**Zinc**][**Alternate corrosion-resistant coating**].
c. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
d. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.3 TYPE ENT DUCT RACEWAYS AND FITTINGS

A. UL FKHU - Electrical Nonmetallic Tubing (ENT) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Cantex Inc.**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cantex Inc.**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FKHU; including UL 1653.

4. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

5. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade**

size 3/4)].

b. Fittings:

1) Mechanically Attached Fittings: UL 1653.
2) Solvent-Attached Fittings: UL 651.

2.4 TYPE HDPE AND TYPE EPEC DUCT RACEWAYS AND FITTINGS

A. UL EAZX - Schedule 40 Electrical HDPE Underground Conduit (HDPE-40):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Schedule 40.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

B. UL EAZX - Schedule 80 Electrical HDPE Underground Conduit (HDPE-80):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Schedule 80.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

C. UL EAZX - Type A Electrical HDPE Underground Conduit (EPEC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Type A.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

D. UL EAZX - Type B Electrical HDPE Underground Conduit (EPEC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN EAZX; including UL 651A.

4. Standard Features:

   a. Dimensional Specifications: Type B.

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.5 TYPE ERMC DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. UL DYWV - Aluminum Electrical Rigid Metal Conduit (ERMC-A), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
d. [**Appleton; Emerson Electric Co., Automation Solutions**]
e. [**Calconduit; Atkore International**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Patriot Aluminum Products, LLC**]
i. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
j. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
k. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
l. [**Topaz Lighting & Electric**]
m. [**Western Tube; Zekelman Industries**]
n. [**Wheatland Tube; Zekelman Industries**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
d. [**Appleton; Emerson Electric Co., Automation Solutions**]
e. [**Calconduit; Atkore International**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Patriot Aluminum Products, LLC**]
i. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
j. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
k. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
l. [**Topaz Lighting & Electric**]
m. [**Western Tube; Zekelman Industries**]
n. [**Wheatland Tube; Zekelman Industries**]
o. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYWV; including UL 6A.

4. Standard Features:

a. Material: Aluminum.
b. Protective Coating: Provide protective coating for [**use in concrete**][**direct burial**][**use in severely corrosive environment**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability

report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL DYWV - Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYWV; including UL 6A.

4. Standard Features:

a. Material: Stainless steel.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Patriot Aluminum Products, LLC**]
f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
g. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
h. [**Topaz Lighting & Electric**]
i. [**Western Tube; Zekelman Industries**]
j. [**Wheatland Tube; Zekelman Industries**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Patriot Aluminum Products, LLC**]
f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
g. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
h. [**Topaz Lighting & Electric**]
i. [**Western Tube; Zekelman Industries**]
j. [**Wheatland Tube; Zekelman Industries**]
k. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYIX; including UL 6.

4. Standard Features:

a. Exterior Coating: Zinc.
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

D. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Bluesteel Services LLC**]
c. [**Calbond; Atkore International**]
d. [**KorKap; Robroy Industries**]
e. [**Perma-Cote; Robroy Industries**]
f. [**Plasti-Bond; Robroy Industries**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Bluesteel Services LLC**]
c. [**Calbond; Atkore International**]
d. [**KorKap; Robroy Industries**]

e. [**Perma-Cote; Robroy Industries**]
f. [**Plasti-Bond; Robroy Industries**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DYIX; including UL 6.

4. Standard Features:

   a. Exterior Coating: PVC complying with NEMA RN 1.
   b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
   c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.
   b. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
   c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.6 TYPE FMC DUCT RACEWAYS

A. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. [**International Metal Hose Co.**]
   e. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]

f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
c. [**Electri-Flex Company**]
d. [**International Metal Hose Co.**]
e. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXUZ; including UL 1.

4. Standard Features:

a. Material: Steel.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL DXUZ - Aluminum Flexible Metal Conduit (FMC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]

b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
c. [**Electri-Flex Company**]
d. [**Topaz Lighting & Electric**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
c. [**Electri-Flex Company**]
d. [**Topaz Lighting & Electric**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXUZ; including UL 1.

4. Standard Features:

a. Material: Aluminum.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.7 TYPE FMT DUCT RACEWAYS

A. UL ILJW - Steel Flexible Metallic Tubing (FMT):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Electri-Flex Company**]
b. [**International Metal Hose Co**]
c. [**Liquid Tight Connector Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Electri-Flex Company**]
b. [**International Metal Hose Co**]
c. [**Liquid Tight Connector Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN ILJW; including UL Subject 1652.

4. Standard Features:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.8 TYPE IMC DUCT RACEWAYS

A. UL DYBY - Steel Intermediate Metal Conduit (IMC):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYBY; including UL 1242.

4. Standard Features:

a. Exterior Coating: [**Zinc**][**Alternative corrosion-resistant coating**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Colors: As indicated on the Drawings.

2.9 TYPE LFMC DUCT RACEWAYS

A. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
    c. [**Electri-Flex Company**]
    d. [**International Metal Hose Co**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
    c. [**Electri-Flex Company**]
    d. [**International Metal Hose Co**]
    e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DXHR; including UL 360.

4. Standard Features:

    a. Material: Steel.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate

scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.

B. UL DXHR - Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXHR; including UL 360.

4. Standard Features:

   a. Material: Stainless steel.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Colors: As indicated on the Drawings.

2.10 TYPE LFNC DUCT RACEWAYS

A. UL DXOQ - Layered (Type A) Liquidtight Flexible Nonmetallic Conduit (LFNC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AFC Cable Systems; Atkore International**]
    b. [**Electri-Flex Company**]
    c. [**Topaz Lighting & Electric**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**AFC Cable Systems; Atkore International**]
    b. [**Electri-Flex Company**]
    c. [**Topaz Lighting & Electric**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

    a. Type A conduit with smooth seamless inner core and cover bonded together with one or more reinforcement layers between core and cover.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
    c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL DXOQ - Integral (Type B) Liquidtight Flexible Nonmetallic Conduit (LFNC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Cambridge Resources**]
c. [**Electri-Flex Company**]
d. [**Superflex Ltd.**]
e. [**Topaz Lighting & Electric**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cambridge Resources**]
c. [**Electri-Flex Company**]
d. [**Superflex Ltd.**]
e. [**Topaz Lighting & Electric**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

a. Type B conduit with smooth inner surface with integral reinforcement within conduit wall.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project

site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

C. UL DXOQ - Corrugated (Type C) Liquidtight Flexible Nonmetallic Conduit (LFNC-C):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**HellermannTyton**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**HellermannTyton**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

a. Type C conduit with corrugated internal and external surfaces without integral reinforcement within conduit wall.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.11 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**NAPCO; Westlake Chemical Corp.**]
e. [**National Pipe and Plastic, Inc. (Oldcastle)**]
f. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**NAPCO; Westlake Chemical Corp.**]
e. [**National Pipe and Plastic, Inc. (Oldcastle)**]
f. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Schedule 40.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**For use with maximum 90 deg C wire**][**For directional boring applications**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DZYR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**National Pipe and Plastic, Inc. (Oldcastle)**]
e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**National Pipe and Plastic, Inc. (Oldcastle)**]
e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Schedule 80.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**For use with maximum 90 deg C wire**][**For directional boring applications**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL DZYR - Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Pipe, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Southern Pipe, Inc.**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DZYR; including UL 651.

4. Standard Features:

   a. Dimensional Specifications: Type A.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL DZYR - Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JM Eagle**]
b. [**Southern Pipe, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**JM Eagle**]
b. [**Southern Pipe, Inc.**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Type EB.
b. Minimum Trade Size: [**Metric designator 53 (trade size 2)**][**Metric designator 78 (trade size 3)**][**Metric designator 103 (trade size 4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.12 TYPE RTRC DUCT RACEWAYS AND FITTINGS

A. UL DZKT - Heavy Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-HW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DZKT; including UL 2515.

4. Standard Features:

    a. Additional Characteristics: Type AG-HW.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DZKT - Standard Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-SW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Champion Fiberglass, Inc**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZKT; including UL 2515.

4. Standard Features:

a. Additional Characteristics: Type SW.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL DZKT - Extra Heavy Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-XW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Champion Fiberglass, Inc**]
b. [**FRE Composites**]
c. [**United Fiberglass of America (UFA)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Champion Fiberglass, Inc**]
b. [**FRE Composites**]
c. [**United Fiberglass of America (UFA)**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DZKT; including UL 2515 and UL 2515A.

4. Standard Features:

    a. Additional Characteristics: Type AG-XW.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL DZKT - Low-Halogen, Belowground Reinforced Thermosetting Resin Conduit (RTRC-BG) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DZKT; including UL 2420.

4. Standard Features:

    a. Additional Characteristics: Type BG.

b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.13 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. UL EBMB - Duct Fittings for Hazardous (Classified) Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
b. [**Power Feed-Thru Systems and Connectors LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
b. [**Power Feed-Thru Systems and Connectors LLC**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EBMB; including UL 1203.

4. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project

site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DWTT - Fittings for Type ERMC, Type IMC, Type PVC, Type HDPE, Type EPEC, and Type RTRC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Konkore Fittings; Atkore International**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**Southwire Company, LLC**]
   i. [**Topaz Lighting & Electric**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Konkore Fittings; Atkore International**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**Southwire Company, LLC**]
   i. [**Topaz Lighting & Electric**]
   j. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DWTT; including UL 514B.

4. Standard Features:

   a. Material: [**Steel**][**Die cast**].
   b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].

c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL FKAV - Fittings for Type EMT Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Calconduit; Atkore International**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Calconduit; Atkore International**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FKAV; including UL 514B.

4. Standard Features:

    a. Material: [**Steel**][**Die cast**].
    b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].
    c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL ILNR - Fittings for Type FMC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Fittings Corp. (AMFICO)**]
    b. [**Liquid Tight Connector Co.**]
    c. [**Southwire Company, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Fittings Corp. (AMFICO)**]
    b. [**Liquid Tight Connector Co.**]
    c. [**Southwire Company, LLC**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN ILNR; including UL 514B.

4. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts

of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arlington Industries, Inc.**]
   b. [**Liquid Tight Connector Co.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arlington Industries, Inc.**]
   b. [**Liquid Tight Connector Co.**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXAS; including UL 514B.

4. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.14 JOINT COMPOUNDS

A. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN FOIZ; including UL Subject 2419.

4. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.15 SOLVENT CEMENTS

A. UL VBEW - Solvent Cements for Nonmetallic Duct Raceways and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Solvent Cements: UL CCN VBEW; including UL 340.
b. Solvent Cement Compatibility with PVC Conduit Fittings: UL CCN DWTT; including UL 514B. Follow solvent manufacturer's published instructions.
c. Solvent Cement Compatibility with Rigid PVC Conduit: UL CCN DZYR; including UL 651. Follow solvent manufacturer's published instructions.
d. Solvent Cement Compatibility with Rigid EPEC and HDPE Underground Conduit: UL CCN EAZX; including UL 651A. Follow solvent manufacturer's published instructions.

4. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in the Contract Documents or manufacturer's published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE[**and EPEC**] underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE[**and Type EPEC**] underground conduits are not permitted to be used aboveground on the Project.

C. Outdoors:

1. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**].
2. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**].
3. Exposed and Not Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**][**PVC-80**][**RTRC-AG**].

4. Concealed Aboveground: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**PVC-40**][**RTRC-AG**].
5. Direct Buried: [**PVC-80**][**PVC-40**][**HDPE-80**][**HDPE-40**][**RTRC-BG**].
6. Concrete Encased Not in Trench: [**PVC-80**][**PVC-40**][**PVC-A**][**RTRC-BG**].
7. Concrete Encased in Trench: [**PVC-80**][**PVC-40**][**PVC-A**][**PVC-EB**][**HDPE-80**][**HDPE-40**][**EPEC-A**][**EPEC-B**][**RTRC-BG**].
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [**LFMC**][**LFNC-A**][**LFNC-B**].

D. Indoors:

1. Hazardous Classified Locations: [**ERMC**][**IMC**].
2. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**].
3. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**EMT**].
4. Exposed and Not Subject to Physical Damage: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**RTRC-AG**].
5. Concealed in Ceilings and Interior Walls and Partitions: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**PVC-40**][**RTRC-AG**].
6. Damp or Wet Locations: [**ERMC**][**IMC**][**RTRC-AG**][**Corrosion-resistant EMT**].
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [**LFMC**][**FMC**][**LFNC-A**][**LFNC-B**].
8. Circuits Operating Above 60 Hz: [**EMT-A**][**ERMC-A**][**RTRC-AG**]. Provide nonmetallic sleeve where aluminum duct raceways pass through concrete.

E. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.
11. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.
12. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
13. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
14. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
15. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
16. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.
17. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
18. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
19. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
20. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
21. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.

22. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
23. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
24. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
25. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
26. Expansion Fittings: NEMA FB 2.40.
27. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

a. Complete duct raceway installation before starting conductor installation.
b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of **2 ft (0.6 m)** above finished floor.
c. Install no more than equivalent of three 90-degree bends in conduit run[**except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted**]. Support within **12 inch (300 mm)** of changes in direction.
d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
f. Support conduit within **12 inch (300 mm)** of enclosures to which attached.
g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:

1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2) Where an underground service duct raceway enters a building or structure.
3) Conduit extending from interior to exterior of building.
4) Conduit extending into pressurized duct raceway and equipment.
5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6) Where otherwise required by NFPA 70.

i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
j. Do not install conduits within **2 inch (50 mm)** of the bottom side of a metal deck roof.
k. Keep duct raceways at least **6 inch (150 mm)** away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than **200 lb (90 kg)** tensile strength. Leave at least **12 inch (300 mm)** of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

1) Termination fittings with shoulders do not require two locknuts.

o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts.[**Install insulated throat metal grounding bushings on service conduits**].

2. Types EMT-A, ERMC-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
3. Types ERMC and IMC:

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

4. Type ERMC-S-PVC:

a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.
c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

5. Types FMC, LFMC, and LFNC:

a. Provide a maximum of [**36 inch (915 mm)**][**72 inch (1830 mm)**] of flexible conduit for [**recessed and semirecessed luminaires,**]equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

6. Types PVC, HDPE, and EPEC:

a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds [**122 deg F (50 deg C)**]<**Insert temperature**>. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
b. Comply with manufacturer's published instructions for solvent welding and fittings.
c. Join joints with solvent cement in accordance with manufacturer's published instructions and allowed to cure before handling. Joints to be bent, pushed, or pulled must set for minimum 24 h after joining.

7. Type RTRC: Do not install Type RTRC conduit where ambient temperature exceeds [**230 deg F (110 deg C)**]<**Insert temperature**>.
8. Duct Raceways Embedded in Slabs:

a. [**Run duct raceways larger than metric designator 27 (trade size 1) below concrete slab**][**Run duct raceways larger than metric designator 27 (trade size) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place duct raceway close to slab support. Secure duct raceways to reinforcement at maximum 10 ft (3 m) intervals**].
b. Arrange duct raceways to cross building expansion joints with expansion fittings at right

angles to the joint.

c. Arrange duct raceways to ensure that each is surrounded by minimum of [**1 inch (25 mm)**][**2 inch (50 mm)**]<**Insert dimension**> of concrete without voids.

d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.

e. Change from ENT to [**PVC-80**][**PVC-40**][**ERMC**][**or**][**IMC**] before rising above floor.

9. Stub-ups to Above Recessed Ceilings:

a. Provide EMT, IMC, or ERMC for duct raceways.

b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

10. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.[**Install insulated throat metal grounding bushings on service conduits**].

11. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

a. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

b. EMT: Provide [**setscrew**][**compression**], [**steel**][**cast-metal**] fittings. Comply with NEMA FB 2.10.

c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

12. Expansion-Joint Fittings:

a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed **30 deg F (17 deg C)** and that have straight-run length that exceeds **25 ft (7.6 m)**. Install in runs of aboveground ERMC[**and EMT**] conduit that are located where environmental temperature change may exceed **100 deg F (55 deg C)** and that have straight-run length that exceeds **100 ft (30 m)**.

b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: [**125 deg F (70 deg C)**]<**Insert temperature**> temperature change.

2) Outdoor Locations Exposed to Direct Sunlight: [**155 deg F (86 deg C)**]<**Insert temperature**> temperature change.

3) Indoor Spaces Connected with Outdoors without Physical Separation: [**125 deg F (70 deg C)**]<**Insert temperature**> temperature change.

4) Attics: [**135 deg F (75 deg C)**]<**Insert temperature**> temperature change.

5) <**Insert location and corresponding temperature change**>.

c. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C)** of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least **0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C)** of temperature change for metal conduits.

d. Install expansion fittings at locations where conduits cross building or structure expansion joints.

e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

13. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty[**or firestopping**].
14. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

    a. Provide warning signs.

15. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturer's published instructions**>.

D. Interfaces with Other Work:

1. Firestop penetrations of fire-rated floor and wall assemblies.
2. Provide conduit hangers and supports.
3. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

4. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

3.3 FIELD QUALITY CONTROL OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum **12 inch (300 mm)** long mandrel equal to duct size minus **1/4 inch (6 mm)**. If obstructions are indicated, remove obstructions and retest.
3. Conduit Placement:

    a. Verify that center-line location and offsets are in accordance with the Drawings.
    b. Verify that hangers and supports for conduits are attached to structure [**in accordance with the Drawings**][**as directed by qualified structural engineer**].
    c. Verify that nuts on bolts or hanger rods are secure.
    d. Verify that space between raceways and cored holes are filled with non-shrinking grout or other approved material indicated on the Drawings and the Specifications.
    e. Verify that expansion devices are installed at locations indicated on the Drawings and the Specifications.
    f. Verify that ends are cut square to provide flush-butting surfaces when spliced and inside edges are free of burrs that could impede installation of cables.
    g. Verify minimum separation of utilities, or that approved mechanical protection has been provided to surrounding conduit(s) where minimum separation cannot be achieved.

4. Document all changes on Record Drawings.

F. Nonconforming Work:

1. Conduit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Verify that bentonite or other drilling fluids are contained and removed, and site is restored to its original or improved condition.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

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SECTION 26 05 43 00A - UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EPEC raceways and fittings.
2. Type ERMC-SS raceways, elbows, couplings, and nipples.
3. Type ERMC-S raceways, elbows, couplings, and nipples.
4. Type IMC raceways.
5. Type PVC raceways and fittings.
6. Type RTRC-BG raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Electrically conductive corrosion-resistant compounds for threaded conduit.
9. Solvent cements.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> specifies preinstallation conference procedures.
4. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
5. Section 260553 "Identification for Electrical Systems" specifies underground-line warning tape and concrete cable routing markers (warning planks).

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For underground ducts and raceways. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For concrete and steel used in precast concrete [**manholes**][**and**][**handholes**], also include product certificates as required by ASTM C858.

B. Sustainable Design Product Data:

1. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Electric Utility Duct Banks and Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Indicate locations of private property boundaries and utility easements.
c. Include information required for approval by electric utility and for obtaining public space utility work permits.

2. Precast or Factory-Fabricated Concrete Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include [**ladder**][**step**] details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
h. Include joint details.

3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

B. Field Reports:

1. Factory Test Reports: For handholes and boxes.
2. Manufacturer's field reports for field quality-control support.

PART 2 - PRODUCTS

2.1 TYPE EPEC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651A and UL CCN EAZX.

B. Schedule 40 Electrical HDPE Underground Conduit (EPEC-40):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Dimensional Specifications: Schedule 40.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

C. Schedule 80 Electrical HDPE Underground Conduit (EPEC-80):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Dimensional Specifications: Schedule 80.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

D. Type A Electrical HDPE Underground Conduit (EPEC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type A.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

E. Type B Electrical HDPE Underground Conduit (EPEC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type B.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.2 TYPE ERMC-SS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6A and UL CCN DYWV.

B. Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

2. Material: Stainless steel.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
b. Colors: As indicated on Drawings.

2.3 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Patriot Aluminum Products, LLC**]
f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
g. [**Topaz Lighting & Electric**]
h. [**Western Tube; Zekelman Industries**]
i. [**Wheatland Tube; Zekelman Industries**]
j. <**Insert manufacturer's name**>

2. Exterior Coating: Zinc.
3. Options:

a. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Colors: As indicated on Drawings.

C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Bluesteel Services LLC**]
c. [**Calbond; Atkore International**]
d. [**KorKap; Robroy Industries**]
e. [**Perma-Cote; Robroy Industries**]
f. [**Plasti-Bond; Robroy Industries**]
g. <**Insert manufacturer's name**>

2. Additional Characteristics:
3. Fittings for PVC-Coated Conduit:

a. Minimum coating thickness of **0.040 inch**, with overlapping sleeves protecting threaded joints.
b. Conduit bodies must be Form 8 with effective seal and positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig

(positive) and 25 inch Hg (vacuum) for 72 hours must be available. Conduit bodies must be supplied with plastic-encapsulated stainless steel cover screws.

c. Form **2 inch** long or one pipe diameter long, whichever is less, PVC sleeve at openings of female fittings, except unions. Inside sleeve diameter must be matched to outside diameter of metal conduit.
d. PVC coating on outside of conduit couplings must be protected from tool damage during installation.
e. Female threads on fittings and couplings must be protected by urethane coating.
f. Fittings must be from same manufacturer as conduit.
g. Beam clamps and U bolts must be formed and sized to fit outside diameter of coated conduit. Plastic-encapsulated nuts must cover exposed portions of threads.

4. Options:

a. Exterior Coating: PVC complying with NEMA RN 1[**and marked ETL Verified PVC-001**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
d. Colors: As indicated on Drawings.
e. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
f. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.4 TYPE IMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1242 and UL CCN DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Topaz Lighting & Electric**]
f. [**Western Tube; Zekelman Industries**]
g. [**Wheatland Tube; Zekelman Industries**]
h. <**Insert manufacturer's name**>

2. Options:

a. Exterior Coating: [**Zinc**][**Alternative corrosion-resistant coating**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
d. Colors: As indicated on Drawings.

2.5 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**NAPCO; Westlake Chemical Corp.**]
e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

2. Dimensional Specifications: Schedule 40.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
b. Markings: [**For use with maximum 90 deg C wire.**][**For directional boring applications.**]

C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
e. [**Topaz Lighting & Electric**]
f. <**Insert manufacturer's name**>

2. Dimensional Specifications: Schedule 80.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
b. Markings: [**For use with maximum 90 deg C wire.**][**For directional boring applications.**]

D. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Southern Pipe, Inc.**]
b. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type A.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

E. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JM Eagle**]
b. [**Southern Pipe, Inc.**]
c. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type EB.
3. Options:

a. Minimum Trade Size: [**Metric designator 53 (trade size 2)**][**Metric designator 78 (trade size 3)**][**Metric designator 103 (trade size 4)**].

2.6 TYPE RTRC-BG RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 2420 and UL CCN DZKT, for Type BG.

B. Low-Halogen, Belowground Reinforced Thermosetting Resin Conduit (RTRC-BG) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.7 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Metallic Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Konkore Fittings; Atkore International**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. <**Insert manufacturer's name**>

2. General Characteristics: UL 514B and UL CCN DWTT.
3. Options:

a. Material: [**Steel**][**Die cast**].
b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].
c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.8 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. <**Insert manufacturer's name**>

2.9 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.
3. Sustainability Characteristics:

a. VOC Content: [**510**][**490**]<**Insert value**> g/L or less for [**PVC**][**CPVC**] conduit and fittings.
b. Low-Emitting Material Requirements: As recommended by solvent and adhesive manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Solvent Cements for Type PVC Raceways and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2.10 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

2.11 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

B. Cast-in-Place Concrete Manholes:

1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.

2. Additional Criteria: Comply with Section 033000 "Cast-in-Place Concrete."

2.12 SOURCE QUALITY CONTROL

A. Factory Tests for Handholes and Boxes:

1. Testing Administrant: [**Owner will engage**][**Engage**] qualified structural testing agency to evaluate handholes and boxes.

a. Tests of materials must be performed by independent testing agency.
b. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.

2. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified testing laboratory's**] certification of system compliance.

a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

3. Nonconforming Work:

a. Equipment that does not pass tests and inspections will be considered defective.

4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Steel raceway, bends, and fittings in [**single duct run or duct bank**][**on Project**] must be of same type.
3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.

4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
5. Install expansion fitting near center of straight line duct with calculated expansion of more than **3/4 inch**.
6. Curves and Bends:

    a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of [**48 inch**][**12.5 ft**][**25 ft**], both horizontally and vertically, at other locations unless otherwise indicated.
    b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of [**48 inch**][**12.5 ft**][**25 ft**]. Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
    c. Duct must have maximum of 180 degrees of bends between pull points.

7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete for minimum of **12 inch** on each side of coupling.

    a. Install insulated grounding bushings on steel raceway terminations that are less than **12 inch** below grade or floor level and do not terminate in hubs.

8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above **104 deg F**. Where environmental temperatures are calculated to rise above **104 deg F**, and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of **104 deg F**.
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately **10 inch** o.c. for **5 inch** duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to end-bell spacing **10 ft** from end bell, without reducing duct slope and without forming trap in line.
    b. Grout end bells into structure walls from both sides to provide watertight entrances.

10. Duct Terminators for Entrances to Cast-in-Place Manholes and Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately **6 inch** o.c. for **4 inch** duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to terminator spacing **10 ft** from terminator, without reducing duct line slope and without forming trap in line.

11. Building Wall Penetrations: Make transition from underground duct to steel raceway at least **10 ft** outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
12. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

    a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete for minimum of **12 inch** on each side of coupling.

13. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least **15 psig** hydrostatic pressure.
14. Pulling Cord: Install **200 lbf** test nylon cord in empty ducts.
15. Concrete-Encased Ducts and Duct Bank:

    a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes **6 inch** or less in nominal diameter.
    b. Width: Excavate trench [**3 inch**][**12 inch**] wider than duct on each side.
    c. Depth: Install so top of duct envelope is at least **24 inch** below finished grade in areas not subject to deliberate traffic, and at least **30 inch** below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
    d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
    e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than [**four**][**five**] spacers per **20 ft** of duct. Place spacers within **24 inch** of duct ends. Stagger spacers approximately **6 inch** between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
    f. Minimum Space between Ducts: **3 inch** between edge of duct and exterior envelope wall, **2 inch** between ducts for like services, and **4 inch** between power and communications ducts.
    g. Elbows:

        1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
        2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of equipment base.

        1) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inchabove**] finished floor and minimum **3 inch** from conduit side to edge of slab.

    i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inchabove**] finished floor and no less than **3 inch** from conduit side to edge of slab.

    j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
    k. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
    l. Concrete Cover: Install minimum of **3 inch** of concrete cover between edge of duct to exterior envelope wall, **2 inch** between duct of like services, and **4 inch** between power and communications ducts.
    m. Place minimum **6 inch** of engineered fill above concrete encasement of duct.
    n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
2) If more than one pour is necessary, terminate each pour in vertical plane and install **3/4 inch** reinforcing-rod dowels extending minimum of **18 inch** into concrete on both sides of joint near corners of envelope.

o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

16. Direct-Buried Duct and Duct Bank:

a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than **6 inch** in nominal diameter.
b. Width: Excavate trench [**3 inch**][**12 inch**] wider than duct on each side.
c. Depth: Install top of duct at least **36 inch** below finished grade unless otherwise indicated.
d. Set elevation of top of duct bank below frost line.
e. Place minimum **3 inch** of sand as bed for duct. Place sand to minimum of **6 inch** above top level of duct.
f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than [**four**][**five**] spacers per **20 ft** of duct. Place spacers within **24 inch** of duct ends. Stagger spacers approximately **6 inch** between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
h. Install duct with minimum of **3 inch** between ducts for like services and **6 inch** between power and communications duct.
i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
j. Install manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct.

1) Couple RNC duct to steel raceway with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete.
2) Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of base. Install insulated grounding bushings on terminations at equipment.

a) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inch above**] finished base and minimum **3 inch** from conduit side to edge of base.

3) Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally on exterior of wall minimum of **60 inch** from edge of wall. Install insulated grounding bushings on terminations at equipment.
4) Stub-ups through interior floors must [**terminate in coupling installed flush**

with][**be minimum 4 inch above**] finished floor and no less than **3 inch** from conduit side to edge of equipment pad or floor slab.

k. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to **4 inch** over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

17. Warning Planks: Bury warning planks approximately **12 inch** above direct-buried duct, placing them **36 inch** o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each **12 inch** increment of duct-bank width over nominal **18 inch**. Space additional planks **12 inch** apart, horizontally across width of ducts.
18. Underground-Line Warning Tape: Bury [**nonconducting**][**conducting**] underground line specified in Section 260553 "Identification for Electrical Systems" no less than **12 inch** above concrete-encased duct and duct banks[**and approximately 12 inch below grade**]. Align tape parallel to and within **3 inch** of centerline of duct bank. Provide additional warning tape for each **12 inch** increment of duct-bank width over nominal **18 inch**. Space additional tapes **12 inch** apart, horizontally across width of ducts.
19. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.2 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Cast-in-Place Manholes:

a. Finish interior surfaces with smooth-troweled finish.
b. Knockouts for Future Duct Connections: Form and pour concrete knockout panels **1-1/2 to 2 inch** thick, arranged as indicated.
c. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

2. Precast Concrete Handholes and Manholes:

a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from **1 inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3. Elevations:

a. Manhole Roof: Install with rooftop at least **15 inch** below finished grade.
b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames **1 inch** above finished grade.
c. Install handholes with bottom below frost line, <**Insert depth of frost line below grade at Project site**> below grade.
d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
e. Where indicated, cast handhole cover frame integrally with handhole structure.

4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.

a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
b. Install chimney, constructed of [**precast concrete**][**cast-iron**] collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.

6. Waterproofing: Apply waterproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Waterproofing materials and installation are specified in [**Section 071353 "Elastomeric Sheet Waterproofing"**][**Section 071354 "Thermoplastic Sheet Waterproofing"**]<**Insert waterproofing Section**>. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
7. Dampproofing: Apply dampproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, [**and**]cable arms, [**and insulators,**]as required for installation and support of cables and conductors and as indicated.
9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than **3-7/8 inch** for manholes and **2 inch** for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
11. Ground manholes, handholes, and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing

conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.3 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:

1. <**Insert reference standard**> for <**Insert reason**>.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from **1/2 inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
4. Install handholes and boxes with bottom below frost line, <**Insert depth of frost line below grade at Project site**> below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in [**asphalt paving**][**and**]<**Insert material**> and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on [**compacted earth**]<**Insert material**>.

a. Concrete: **3000 psi**, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
b. Dimensions: [**10 inch wide by 12 inch deep**]<**Insert dimensions**>.

8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing**

related Work>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum **12 inch** long mandrel equal to duct size minus **1/4 inch**. If obstructions are indicated, remove obstructions and retest.
3. Test manhole[**and handhole**] grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

D. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

END OF SECTION 26 05 43 00A

Task	Specification	Specification Description
26 05 43 00	26 01 00 00	Supplemental Requirements for Electrical
26 05 43 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 43 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 43 00	26 05 19 16	Communications Equipment Room Fittings
26 05 43 00	26 05 19 16a	Communications Copper Backbone Cabling
26 05 43 00	26 05 19 16b	Communications Coaxial Horizontal Cabling

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SECTION 26 05 46 00 - POLES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting standards.
2. Lighting standard accessories.
3. Utility poles.
4. Utility pole accessories.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding components referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
8. [**Section 262726 "Wiring Devices"**][**Section 262726.31 "General-Grade Single Straight-Blade Receptacles"**][**and**][**Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles"**] specify receptacles referenced by this Section.
9. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.
5. Product Certificates: Include product certificate, signed by manufacturers of poles, certifying that products are designed for indicated load requirements in accordance with AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification must be based on design calculations signed and sealed by a professional engineer.
6. Include manufacturer's sample extended warranty language.

B. Samples: Submit finish samples for each exposed lighting pole, standard, and luminaire-supporting

device and for each color and texture specified.

C. Shop Drawings: Prepare and submit the following:

1. Plans, elevations, sections, and [**mounting**][**and**][**attachment**] details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Details of fabrication and assembly of [**poles**][**and**][**pole accessories**].
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's published installations.

D. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports:

1. For each foundation component, by qualified testing laboratory.
2. For each pole, by qualified testing laboratory.

B. Soil test reports.

C. Manufacturer's published instructions.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.5 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed [**pole(s)**][**and luminaire-lowering device(s)**] perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that [**pole(s)**][**and luminaire-lowering device(s)**] perform in accordance with specified requirements and agrees to provide repair or replacement of products that fail to perform as specified within extended-warranty period, including materials that corrode, fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Warranty Period for Corrosion Resistance: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
3. Warranty Period for Color Retention: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Description: <**Insert brief description of desired system, assembly, or equipment**>.

B. Performance Criteria:

1. Regulatory Requirements:

   a. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Utility Approval: Comply with <**Insert name of utility**> requirements.
3. General Characteristics:

   a. Structural Characteristics: Comply with AASHTO LTS-6-M.
   b. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied in accordance with AASHTO LTS-6-M.
   c. Live Load: Single load of **500 lb** distributed in accordance with AASHTO LTS-6-M.
   d. Ice Load: Load of **3 lb/ft2**, applied in accordance with AASHTO LTS-6-M for applicable areas on the Ice Load Map.
   e. Wind Load for Poles Exceeding 50 ft (15 m) Height:

      1) Basic Wind Speed: [**100 mile/h**][**90 mile/h**]<**Insert value from AASHTO LTS-6-M for this Project**>.
      2) Wind Importance Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.
      3) Minimum Design Life: [**50 years**]<**Insert value from AASHTO LTS-6-M**>.
      4) Velocity Conversion Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.

   f. Wind Load for Poles Not Exceeding 50 ft (15 m) Height:

      1) Basic Wind Speed: [**100 mile/h**][**90 mile/h**]<**Insert value from AASHTO LTS-6-M for this Project**>.
      2) Wind Importance Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.
      3) Minimum Design Life: [**25 years**]<**Insert value from AASHTO LTS-6-M**>.
      4) Velocity Conversion Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.

   g. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of [**1.1**]<**Insert number**> to obtain the EPA used in pole selection strength analysis.
   h. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
   i. General Finish Requirements:

      1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2) Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.2 LIGHTING STANDARDS

A. Steel Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American LitePole**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Bridgewell Resources**]
d. [**Cooper Lighting Solutions; Signify North America Corp.**]
e. [**E-conolight**]
f. [**H.E. Williams**]
g. [**Hapco**]
h. [**Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
k. [**LSI Industries**]
l. [**Millerbernd Manufacturing Company**]
m. [**NAFCO; brand of Wisconsin Lighting Lab, Inc.**]
n. [**RAB Lighting**]
o. [**Ruud Lighting; brand of Cree Lighting; subsidiary of Ideal Industries, Inc.**]
p. [**Union Metal Industries Corp.**]
q. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. Carbon Steel Poles: Comply with ASTM A500/A500M, Grade B carbon steel with a minimum yield of **46,000 psig**; one-piece construction up to **40 ft** in height with access handhole in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

e. Stainless Steel Poles: Comply with [**ASTM A240/A240M**][**ASTM A666**], stainless steel with a minimum yield of **55,000 psig**; one-piece construction up to **40 ft** in height with access handhole in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

f. Steel Mast Arms: [**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate.

g. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor fitting welded to lighting standard, allowing the bracket to be bolted to the lighting standard-mounted adapter, then bolted together with [**stainless steel**][**galvanized-steel**] bolts.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

h. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to lighting standard top.

i. Grounding and Bonding Lugs: Welded **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

j. Steps: Fixed steel, with nonslip treads.

1) For climbing positions, install at **15 inch** vertical spacing, alternating on opposite sides of lighting standard, oriented 180 degrees from each other; first step must be at an elevation **10 ft** above finished grade.
2) For working positions, install steps on opposite side of lighting standard, oriented 180 degrees from each other at the same elevation.

k. Handhole: Oval shaped, with minimum clear opening of **2-1/2-by-5 inch**, with cover secured by stainless steel captive screws.

l. Intermediate Handhole and Cable Support: Weatherproof, **3-by-5 inch** handhole located at midpoint of lighting standard, with cover for access to internal welded attachment lug for electric cable support grip.

m. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.

n. Platform for Lamp Ballast Servicing: Factory fabricated of steel, with finish matching that of lighting standard.

o. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

p. Galvanized Finish: After fabrication, hot-dip galvanize in accordance with ASTM A123/A123M.

q. Factory-Painted Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces in accordance with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

r. Powder-Coat Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces in accordance with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder-coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Powder Coat: Comply with AAMA 2604.

a) Electrostatic-applied powder coating; single application and cured to a minimum **2.5 to 3.5 mil** dry film thickness. Coat interior and exterior of lighting standard for equal corrosion protection.
b) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

B. Aluminum Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American LitePole**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Bridgewell Resources**]
d. [**Cooper Lighting Solutions; Signify North America Corp.**]
e. [**E-conolight**]
f. [**H.E. Williams**]
g. [**Hapco**]
h. [**Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
k. [**LSI Industries**]
l. [**Lyte Poles; brand of DWM Holdings, Inc.**]
m. [**NAFCO; brand of Wisconsin Lighting Lab, Inc.**]
n. [**Ruud Lighting; brand of Cree Lighting; subsidiary of Ideal Industries, Inc.**]
o. [**Sentry Electric, LLC**]

p. [**Union Metal Industries Corp.**]
q. [**Valmont Industries, Inc.**]
r. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. [**Seamed**][**Seamless**], extruded structural tube complying with ASTM B221, [**Alloy 6063-T6**][**Alloy 6061-T6**], with access handhole in in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

e. Mast Arms: [**Aluminum**][**Steel**][**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate.
f. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor fitting welded to lighting standard, allowing the bracket to be bolted to the lighting standard-mounted adapter, then bolted together with [**stainless steel**][**galvanized-steel**] bolts.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

g. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to lighting standard top.
h. Grounding and Bonding Lugs: Bolted **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
i. Handhole: Oval shaped, with minimum clear opening of **2-1/2 by 5 inch**, with cover secured by stainless steel captive screws.
j. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
k. Aluminum Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2) Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3) Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin;

Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.

4) Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

l. Factory-Painted Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

m. Powder-Coat Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Powder coat must comply with AAMA 2604.

a) Electrostatic applied powder coating; single application with a minimum **2.5 to 3.5 mil** dry film thickness; cured in accordance with manufacturer's published instructions. Coat interior and exterior of lighting standard for equal corrosion protection.
b) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as to substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

C. Fiberglass Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alliance; a division of GEOTEK**]
b. [**Bridgewell Resources**]
c. [**CMT; a Valmont Company**]
d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**PLP Composite Technologies, Inc**]
f. [**Shakespeare; a Valmont Company**]
g. [**Valmont Industries, Inc.**]
h. [**Whately; a Valmont Company**]
i. [**Wood Preservers, Inc.**]
j. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. Designed specifically for supporting luminaires, with factory-formed cable entrance and handhole.
e. Not less than 65 percent by weight of fiberglass roving, with resin and pigment making up the remainder.
f. Roving must be continuously applied with uniform tension, with multiple layers placed to meet axial and compressive strength requirements.
g. Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
h. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
i. Surface Finish: Smooth and uniform along surface of lighting standard.
j. Paint Finish: Pigmented polyurethane, with a minimum dry film thickness of **1.5 mil**. Polyurethane may be omitted if the surface layer of the lighting standard is inherently UV inhibited.
k. Mast Arms: [**Aluminum**][**Steel**][**Fiberglass**][**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate. Adaptor plate must be steel hot-dip galvanized in accordance with ASTM A153/A153M or Alloy 6061-T6 aluminum encased within fiberglass roving, allowing the mast arm adaptor to be bolted to the lighting standard.
l. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor Fitting: Steel, hot-dip galvanized in accordance with ASTM A153/A153M, or Alloy 6061-T6 aluminum, permanently bonded within fiberglass roving, allowing the bracket to be bolted to the lighting standard-mounted adapter. Bolt together with [**stainless steel**][**galvanized-steel**] bolts; use anti-seize compound when bolting dissimilar metals.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

m. Pole-Top Tenons: Steel, hot-dip galvanized in accordance with ASTM A153/A153M, or Alloy 6061-T6 aluminum, permanently bonded to the fiberglass shaft. Fabricated to support luminaire or luminaires and brackets indicated.
n. Handhole: Oval shaped, with minimum clear opening of **2-1/2 by 5 inch**, with cover secured by stainless steel captive screws.
o. Grounding: Bare, stranded copper, 6 AWG, [**suspended inside of lighting standard**][**inside 3/4 inch conduit fastened to the interior of the lighting standard**], connected to luminaire(s), ground lug near handhole, and ground rod.
p. Grounding and Bonding Lugs: Bolted **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

4. Other Available Features Required by the Project:

a. Resin Color: [**Black**][**Dark**][**Bronze**]<**Insert color**>; uniform coloration throughout entire wall thickness.
b. Anchor Base: Integral galvanized-steel or aluminum casting, enclosing and permanently bonded to the exterior of the fiberglass shaft.
c. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

D. Laminated Wood Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bell Lumber and Pole Company**]
b. [**Hughes Brothers, Inc.**]
c. [**Laminated Wood Systems, Inc.**]
d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**McFarland Cascade**]
f. [**Timber Technologies, LLC**]
g. [**TimberWood Products; J.H. Baxter & Co.**]
h. [**Valmont Industries, Inc.**]
i. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. Species and Grades for Structural Laminated Timber: Complying with APA A190.1. Use [**Southern pine**][**Douglas fir**][**Alaska cedar**][**any species listed in APA 117**], engineered and fabricated to withstand indicated structural loads without exceeding allowable design working stresses in accordance with [**APA 117**][**AWPA/ANSI O5.2**].
e. Features include [**wood bracket**][**wood crossarm**][**lighting standard-top adaptor**]<**Insert items**> for mounting luminaire(s), metal lighting standard cap, and concealed raceway path connected to access handhole.
f. Mounting Provisions: [**Embedded**]<**Insert description of other mounting unless detailed on the Drawings**>.
g. Appearance Grade: Architectural appearance grade complying with AITC 110.
h. Preservative Treatment:

1) Exposure: Comply with [**AWPA U1, Use Category UC4A**][**AWPA U1, Use Category UC4B**][**AWPA U1, Use Category UC4C**].
2) Treatment after Dressing and End Cutting: Comply with AWPA M4 for surface cuts to a depth of more than **1/16 inch**.

i. Adhesive: Wet-use type complying with ASTM D2559.
j. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
k. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.
l. Finish: [**Natural, unstained wood**][**Semitransparent stain applied after erection**][**Factory-applied semitransparent stain**], color as selected by Architect.

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as to substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

E. Wood Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Pole & Timber**]
b. [**Baldwin Pole & Piling Co., Inc.**]
c. [**Bell Lumber and Pole Company**]
d. [**Cavawood Architectural Products**]
e. [**Cobb Lumber Company**]

f. [**Cox Utility Products Division**]
g. [**Guelph Utility Pole Co., Ltd.; a Stella-Jones company**]
h. [**Koppers Performance Chemicals**]
i. [**Langdale Forest Products Company**]
j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
k. [**McFarland Cascade**]
l. [**Stella-Jones**]
m. [**T.R. Miller Mill Co., Inc.**]
n. [**Texas Electric Cooperatives, Inc.**]
o. [**Thomasson Company**]
p. [**TimberWood Products; J.H. Baxter & Co.**]
q. [**United Wood Treating Company**]
r. [**Wood Preservers, Inc.**]
s. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. [**Douglas fir**][**Southern yellow pine**], [**machine trimmed by turning,**] for wood species used; and bored, roofed, and grained before treatment.

1) Pole Brand: Brand the manufacturer's trademark and date of treatment, height and class of lighting standard, wood species, preservation code, and retention. Brand must be placed so that the bottom of the brand is minimum **10 ft** from lighting standard butt.
2) Mounting Provisions: Embedded.

e. Preservative Treatment: Treat in accordance with [**AWPA U1, Use Category UC4A**][**AWPA U1, Use Category UC4B**][**AWPA U1, Use Category UC4C**].
f. Luminaire Brackets: Comply with NEMA/ANSI C136.13.

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after

fabrication unless otherwise indicated.

F. Prestressed Concrete Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Baldwin Pole & Piling Co., Inc.**]
   b. [**Holophane; an Acuity Brands company**]
   c. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
   d. [**Lonestar Prestress Mfg., Inc.**]
   e. [**NOV Ameron**]
   f. [**Pre-Cast Specialties, Inc.**]
   g. [**Seminole Pole, Inc.**]
   h. [**StressCrete Group**]
   i. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

   a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
   b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
   c. General Finish Requirements:

      1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
      2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

   d. Comply with ASTM C1089[**and manufactured by centrifugal spin-casting process**][**and manufactured by static-casting method**].

      1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
      2) Mounting Provisions: [**Steel butt flange for bolted mounting to foundation or breakaway support**][**Embedded**].
      3) Finishing: Capped at top and plugged at bottom. Seat each reinforcing strand with epoxy adhesive.
      4) Grounding: Continuous copper ground wire cast into lighting standard. Terminate at top of lighting standard[**and attach to 24 inch lighting rod**].
      5) Raceway: Smooth, internal, and not less than **3 inch** in diameter.

   e. Concrete: Minimum 28-day compressive strength of [**7000 psi**]<**Insert value**>.
   f. Cured with wet steam and aged for a minimum of 15 days prior to installation.
   g. Reinforcement: [**Reinforcing bars complying with ASTM A615/A615M**][**Cold-drawn spiral wire complying with ASTM A1064/A1064M**][**Prestressing strand, 270 K, complying with ASTM A416/A416M**].
   h. Surface Treatment: Hard, nonporous, and resistant to water, frost, and road and soil chemicals; and must have a maximum water-absorption rate of 3 percent.

i. Finish Texture: [**Standard form**][**Polished exposed aggregate**][**Etched exposed aggregate**].

1) Exposed aggregate must be of <**Insert aggregate type selected from manufacturers' lists**> type.

j. Nameplate: Aluminum cast into lighting standard wall at approximately **5 ft** above ground line, listing name of manufacturer, the Project identifier, overall height, and approximate weight.

k. Pole Brackets: Comply with NEMA/ANSI C136.31.

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.

2.3 LIGHTING STANDARD ACCESSORIES

A. Duplex Receptacle: Ground-fault circuit interrupter type, 120 V(ac), 20 A in a weatherproof assembly.

1. [**Surface mounted**][**Recessed**][**12 inch**]<**Insert dimensions**> above finished grade.

a. UL 50E, [**Type 3R**][**Type 4X**], nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.

b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.

B. Minimum 1800 W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

D. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept [**ballast(s)**][**indicated accessories**]. Include removable flanged access cover secured with bolts or screws.

E. Decorative accessories, supplied by decorative pole manufacturer, include the following:

1. Banner Arms: <**Insert material**>.
2. Flag Holders: <**Insert material**>.
3. Ladder Rests: <**Insert material**>.

F. Lowering System for Luminaires:

1. System Description: Capable of lowering luminaire [**assembly**]to a service position within **36 inch** of finished grade in winds up to **30 mile/h**. Provide manual plug connection to electrical power accessible in lowered position. Assembled system of pole, luminaire, and lowering device must be capable of loads specified in "Performance Requirements" Article.
2. Compatibility of Material: Materials for attachment and connection of luminaire-mounting assembly, lowering device, lowering cable, and portable winch must be compatible to avoid corrosion and electrolysis.
3. Structural and Mechanical Design Safety Factor: 5.0, minimum, for static and dynamic loads of

load-bearing components, including cable.

4. Luminaire-Mounting and Disconnect Arrangement: Multiple [**ring**][**carriage**]-mounted luminaires, arranged for lowering and rising as a group.

    a. Electrical cable for normal operating power to luminaires must manually disconnect inside pole base, using weatherproof multi-pin connector, and must be arranged to move within the pole during lowering and rising of luminaire assembly.
    b. Electrical cable for normal operating power to luminaires must automatically disconnect at weatherproof multi-pin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnect when luminaire or luminaire assembly is raised to the operating position.

5. Lowering Device: Weatherproof, cast-aluminum housing, and multiple mechanical latches. Moving parts of latching assembly must be located in the portion of the unit that is lowered to servicing position. Positive latching in the operating position must be indicated to the operator at the base of the pole by a clear visual signal or by other means acceptable to Owner or authorities having jurisdiction.
6. Lowering Cable: [**Zinc-electroplated-steel**][**or**][**stainless steel**] aircraft cable.
7. Portable Winch: [**Manual**][**120 V electric**] type. [**One**]<**Insert number**> required.

    a. Winch Power Connection: Cord and plug.
    b. Winch Raise-Lower Control: Remote-control station with [**15 ft**]<**Insert dimension**> of cable.

G. Mounting Hardware:

1. Anchor Bolts: Manufactured [**to ASTM F1554, Grade 55,**]with a minimum yield strength of **55,000 psi**.

    a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
    b. [**Bent**][**Headed**] rods <**Insert dimension**> in diameter by <**Insert dimension**> in length.
    c. Threading: [**Uniform National Coarse**][**Uniform National 8**], Class 2A.

2. Nuts: ASTM A563/A563M, Grade A, Heavy-Hex.

    a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
    b. [**Two**][**Four**]<**Insert number**> nuts provided per anchor bolt[**, shipped with nuts preassembled to the anchor bolts**].

3. Washers: ASTM F436/F436M, Type 1.

    a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
    b. [**One**][**Two**]<**Insert number**> washer(s) provided per anchor bolt.

2.4 UTILITY POLES

A. Wood Utility Pole:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Pole Company**]
b. [**Baxter, J. H. & Co**]
c. [**Bell Lumber and Pole Company**]
d. [**Brown Wood Preserving Co., Inc.**]
e. [**Dayton Superior Corporation**]
f. [**Koppers Performance Chemicals**]
g. [**McFarland Cascade**]
h. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain poles from single manufacturer or producer**][**For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with [**creosote**][**pentachlorophenol**][**ammoniacal copper arsenate**][**ammoniacal copper zinc arsenate**][**and**][**chromated copper arsenate**].
b. Wood Species: [**Douglas fir**][**Lodgepole pine**][**Western larch**][**Southern yellow pine**]<**Insert wood species selected from ATIS O5.1**>.
c. Pole Marking:

1) Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft** from the pole butt for poles **50 ft** long or less.
2) Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch** high, with aluminum nails.

d. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

B. Concrete Utility Pole:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Accord Industries**]
b. [**Bayshore Concrete Products Corporation**]
c. [**CPI Concrete Products**]
d. [**StressCrete Group**]
e. [**Valmont Industries, Inc.**]
f. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain poles from single manufacturer or producer**][**For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Spun-cast prestressed concrete, complying with requirements of ASTM C1089.

1) Comply with requirements of RUS Bulletin 1724E-216.

b. Design: Base design on calculation of strength required by IEEE C2 or indicated on the Drawings, whichever is greater. Design must be suitable for installation at a location where annual temperature range is between [**minus 4 deg F and plus 100 deg F**]<**Insert design**

temperature range at site location>. Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.

c. Shaft: Hollow, for poles at overhead-to-underground connections. Provide metric designator 91 (trade size 3-1/2) minimum cable raceway capacity, with [**conduit elbow**][**cable entry port**] at base.

d. Water Absorption: Not more than 3 percent.

e. Surface: Smooth, hard, nonporous, and resistant to [**soil acids**][**road salts**][**frost and freezing damage**].

f. Pole Marking:

1) Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft** from the pole butt for poles **50 ft** long or less.

2) Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch** high.

2.5 UTILITY POLE ACCESSORIES

A. Crossarms:

1. Description: [**Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade**][**Galvanized, steel angles**], and complying with IEEE C2 for required climbing space and wire clearances.
2. Braces: Galvanized, flat, ferrous-metal units; **1/4 inch** thick by **1-1/4 inch** wide, minimum, with length to suit crossarm dimensions.

B. Guys and Anchors:

1. Guy Strand Assemblies: Cable and attachment assemblies must have uniform minimum breaking strength of the cable.

a. Cable: Seven strands. [**Zinc-coated steel, complying with ASTM A475**][**Aluminum-clad steel, complying with ASTM B416**][**Copper-clad steel, complying with ASTM B228**]. Breaking strength must be not less than [**10,000 lb**]<**Insert value**>.

b. Cable Termination:

1) Thimble eye.
2) Hooks and guy strain plates, complying with IEEE C135.1.
3) Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.

2. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.

a. Power-installed, screw-type anchors.

1) **15 inch** screw; with rod **8 ft** long by **1-1/2 inch** in diameter. Rated at **10,000 lb** when installed.
2) Guy anchors must have strength and holding area as required for anchor load and soil conditions at location of that anchor.

b. <**Insert anchor size or type**>.

3. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Installation of Guys and Anchors" Subparagraph in "Installation of Utility Poles" Article.
4. Guy Markers: Round, of vinyl or PVC material, [**white**][**yellow**] color, **8 ft** long. Shatter resistant at temperatures below **0 deg F**.

PART 3 - EXECUTION

3.1 INSTALLATION OF FOUNDATIONS FOR POLES AND LIGHTING STANDARDS

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Precast Foundations: Factory fabricated, with structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

C. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.

1. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.

D. Direct-Buried Foundations: Install to depth indicated on the Drawings, but not less than [**one-sixth of pole height**][**as indicated**]. Add backfill [**in 6 to 9 inch layers, tamping each layer before adding the next**][**as indicated on the Drawings**]<**Insert requirement**>. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

E. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on the Drawings, but not less than [**one-sixth of pole height**][**as indicated**]. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

1. Make holes **6 inch** in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of **3000 psi** at 28 days and finish in a dome above finished grade.
3. Use a short piece of **1/2 inch** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

F. Anchor Bolts: Install plumb using manufacturer-supplied [**steel**][**plywood**] template, uniformly spaced.

3.2 INSTALLATION OF LIGHTING STANDARDS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Hot Work: NFPA 51B.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Alignment: [**Align foundations and lighting standards for optimum directional alignment of luminaires and their mounting provisions on lighting standards**][**Align lighting standards as indicated**].
2. Clearances: Maintain the following minimum horizontal distances of lighting standards from surface and underground features unless otherwise indicated on the Drawings:

    a. Fire Hydrants and Water Piping: [**60 inch**]<**Insert dimension**>.
    b. Water, Gas, Electric, Communications, and Sewer Lines: [**10 ft**]<**Insert dimension**>.
    c. Trees: **15 ft** from tree trunk.
    d. <**Insert features and clearance dimensions**>.

3. Concrete Lighting Standard Foundations: Set anchor bolts in accordance with anchor-bolt templates furnished by manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
4. Foundation-Mounted Lighting Standards: Mount lighting standards with leveling nuts and tighten top nuts to torque level in accordance with manufacturer's published instructions.

    a. Use anchor bolts and nuts selected to resist seismic forces specified for the application and approved by manufacturer.
    b. Grout void between lighting standard base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
    c. Install base covers unless otherwise indicated.
    d. Use a short piece of **1/2 inch** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of lighting standard.

5. Lighting Standards and Foundations Set in Concrete-Paved Areas: Install lighting standards with a minimum **6 inch** wide, unpaved gap between the lighting standard or foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level **1 inch** below top of concrete slab.
6. Raise and set lighting standard using web fabric slings (not chain or cable) at locations indicated by manufacturer.
7. Corrosion Prevention:

    a. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.
    b. Steel Conduits: Comply with requirements in Section 260533.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with **0.010 inch** thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

D. Interfaces with Other Work:

1. Grounding and Bonding: Bond metallic components of lighting standards and support structures as follows:

    a. Provide insulated equipment grounding conductors with supply feeders for bonding luminaires and other pole-mounted electrical or electronic equipment to ground terminals of their supplying power sources in accordance with Article 250 of NFPA 70.
    b. Bond metallic components of luminaires, pole accessories, and foundation to insulated equipment grounding conductor.

2. Identification: Provide labels for lighting standards, components, wiring, cabling, terminals, and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.

b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3.3 INSTALLATION OF UTILITY POLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: [**IEEE C2**][**NFPA 70 and NECA NEIS 1**].
2. Electrical Safety: NFPA 70E.
3. Hot Work: NFPA 51B.
4. Grounding and Bonding: [**IEEE C2**][**NECA NEIS 331 and Article 250 of NFPA 70**].
5. Communications Work: BICSI N1.
6. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document must also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.
2. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
3. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and in accordance with the following:

   a. On level ground, set poles so tops of consecutive poles vary not more than **60 inch** in elevation.
   b. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.

4. Set poles in accordance with the following:

   a. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
   b. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:

      1) Poles up to 35 ft (10.6 m) Long: **24 inch**.
      2) Poles 36 to 60 ft (11 to 18.3 m) Long: **30 inch**.
      3) Poles 61 to 75 ft (18.6 to 22.9 m) Long: **36 inch**.

   c. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
   d. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain **1 inch** minimum, **2 inch** maximum, (after conductors are installed at required tension) for each **10 ft** of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
   e. Backfill holes in **6 inch** maximum lifts, and thoroughly tamp each layer before starting the

next.

f. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
g. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead ends; place gains on last two poles on side facing terminal or dead end.
h. Poles Set in Concrete Paved Areas: Install poles with minimum of **6 inch** wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with [**pea gravel**]<**Insert appropriate material**> to a level **1 inch** below top of concrete slab.

5. Field treat factory-treated poles and crossarms as follows:

   a. Poles Treated More Than One Year before Installation: Treat portion from **24 inch** above ground line to butt.
   b. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
   c. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
   d. Engage the services of qualified wood pole and crossarm treatment technician to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.

6. Installation of Crossarms: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

   a. Buck Arms: Install at corners and junction poles unless otherwise indicated.
   b. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
   c. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
   d. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

7. Installation of Guys and Anchors:

   a. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inch** or more. Comply with IEEE C2.

      1) Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
      2) At the anchor end, attach guy strand assembly with preformed grips.

   b. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.
   c. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio must be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.
   d. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inch** from ground.
   e. Install strain insulators to provide a minimum of **12 inch** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators must be loaded to not more than two-thirds of manufacturer's published rating.

8. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

D. Interfaces with Other Work:

1. Grounding and Bonding:

    a. Comply with [**IEEE C2**][**NFPA 70**] grounding and bonding requirements.
    b. Ground Rods: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch by 10 ft**][**5/8 inch by 8 ft**].

        1) Install [**two**]<**Insert number**> parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 Ω.
        2) Drive ground rods until tops are **12 inch** below finished grade in undisturbed earth.

    c. Grounding (Earthing) Conductors:

        1) 4 AWG minimum, soft-drawn copper.
        2) Conductor Protectors for Wood Poles: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communications service and transformer spaces.
        3) Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
        4) Lightning Arrester Grounding Conductors: Separate from other grounding conductors.

    d. Bonding Conductors: Provide equipment grounding conductors with supply feeders for bonding pole-mounted electrical and electronic equipment to ground terminals of their supplying power sources in accordance with Article 250 of NFPA 70.

2. Identification: Provide labels for poles, components, wiring, cabling, terminals, and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
    d. Locate pole numbers to provide maximum visibility from the road or patrol route.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Inspect poles for nicks, mars, dents, scratches, and other damage.
2. System function tests.
3. Guy Anchors: Test one of each type and capacity installed[**, plus additional units specifically indicated for testing**]. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

    a. Acceptable Test Results: Denoted by movement of less than **3/8 inch** by the holding component of the anchor in the earth or other medium in which it is installed.
    b. Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.

4. Pole Ground Resistance: Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.

    a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
    b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground, tested individually, exceeds 25 Ω, add a ground electrode not less than **10 ft** away and interconnect with 2 AWG, minimum, bare conductor buried at least **12 inch** below furnished grade.

5. <**Insert special inspections**>.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

END OF SECTION 26 05 46 00

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Task	Specification	Specification Description
26 05 46 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 53 00 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Extruded insulating tubing.
3. Bands.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 284600 "Fire Detection and Alarm"[**and Section 284614 "Single- and Multiple-Station Alarms"**] specifies fire detection and alarm devices referenced in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

B. UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Champion America**]
c. [**emedco**]
d. [**Grafoplast Wire Markers**]
e. [**HellermannTyton**]
f. [**LEM Products Inc.**]
g. [**Marking Services Inc.**]
h. [**Panduit Corp**]
i. [**Seton Identification Products; a Brady Corporation company**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Champion America**]
c. [**emedco**]
d. [**Grafoplast Wire Markers**]
e. [**HellermannTyton**]
f. [**LEM Products Inc.**]
g. [**Marking Services Inc.**]
h. [**Panduit Corp**]
i. [**Seton Identification Products; a Brady Corporation company**]
j. <**Insert manufacturer's name**>

C. UL PGDQ2 - Self-Adhesive Wraparound Labels: [**Preprinted**][**Write-on**], **3 mil (0.08 mm)** thick, [**polyester**][**vinyl**] flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**Ideal Industries, Inc.**]
g. [**LEM Products Inc.**]
h. [**Marking Services Inc.**]
i. [**Panduit Corp**]
j. [**Seton Identification Products; a Brady Corporation company**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**Ideal Industries, Inc.**]
g. [**LEM Products Inc.**]
h. [**Marking Services Inc.**]
i. [**Panduit Corp**]
j. [**Seton Identification Products; a Brady Corporation company**]
k. <**Insert manufacturer's name**>

3. Self-Lamination: Clear; UV-, weather-, and chemical-resistant; self-laminating, with protective shield over legend. Size labels such that clear shield overlaps entire printed legend.
4. Marker for Labels:

a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. UL PGDQ2 - Self-Adhesive Labels: [**Polyester**][**Vinyl**], thermal, transfer-printed, **3 mil (0.08 mm)** thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**HellermannTyton**]
g. [**Ideal Industries, Inc.**]
h. [**LEM Products Inc.**]
i. [**Marking Services Inc.**]
j. [**Panduit Corp**]
k. [**Seton Identification Products; a Brady Corporation company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**HellermannTyton**]
g. [**Ideal Industries, Inc.**]
h. [**LEM Products Inc.**]

i. [**Marking Services Inc.**]
j. [**Panduit Corp**]
k. [**Seton Identification Products; a Brady Corporation company**]
l. <**Insert manufacturer's name**>

3. Minimum Nominal Size:

a. **1-1/2 by 6 inch (37 by 150 mm)** for raceway and conductors.
b. **3-1/2 by 5 inch (76 by 127 mm)** for equipment.
c. As required by authorities having jurisdiction.

2.2 EXTRUDED INSULATING TUBING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

B. UL YDPU2 - Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of **200 deg F (93 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Panduit Corp**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Panduit Corp**]
c. <**Insert manufacturer's name**>

2.3 BANDS

A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]

b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, **2 inch (50 mm)** long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. <**Insert manufacturer's name**>

2.4 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**HellermannTyton**]

e. [**Ideal Industries, Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**HellermannTyton**]
e. [**Ideal Industries, Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. <**Insert manufacturer's name**>

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than **3 mil (0.08 mm)** thick by **1 to 2 inch (25 to 50 mm)** wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. <**Insert manufacturer's name**>

C. Tape and Stencil: **4 inch (100 mm)** wide black stripes on **10 inch (250 mm)** centers placed diagonally over orange background and are **12 inch (300 mm)** wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HellermannTyton**]
b. [**LEM Products Inc.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]

f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**HellermannTyton**]
b. [**LEM Products Inc.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. **<Insert manufacturer's name>**

D. Floor Marking Tape: **2 inch (50 mm)** wide, **5 mil (0.125 mm)** pressure-sensitive vinyl tape, with [**black and white**][**yellow and black**] stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Seton Identification Products; a Brady Corporation company**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Seton Identification Products; a Brady Corporation company**]
d. **<Insert manufacturer's name>**

E. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Ideal Industries, Inc.**]
c. [**LEM Products Inc.**]
d. [**Marking Services Inc.**]
e. [**Pipemarker.com; Brimar Industries, Inc.**]
f. [**Reef Industries, Inc.**]
g. [**Seton Identification Products; a Brady Corporation company**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]

b. [**Ideal Industries, Inc.**]
c. [**LEM Products Inc.**]
d. [**Marking Services Inc.**]
e. [**Pipemarker.com; Brimar Industries, Inc.**]
f. [**Reef Industries, Inc.**]
g. [**Seton Identification Products; a Brady Corporation company**]
h. <**Insert manufacturer's name**>

3. Tape:

a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical [**and communications**]utility lines.
b. Printing on tape must be permanent and may not be damaged by burial operations.
c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

4. Color and Printing:

a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
b. Inscriptions for Red Tapes: [**"CAUTION BURIED ELECTRIC LINE BELOW"**]<**Insert inscription**>.
c. Inscriptions for Orange Tapes: [**"CAUTION BURIED CATV LINE BELOW"**][**"CAUTION BURIED TELEPHONE LINE BELOW"**][**"CAUTION BURIED FIBER OPTIC LINE BELOW"**][**"CAUTION BURIED COMMUNICATION LINE BELOW"**]<**Insert inscription**>.

5. Nonconducting Line-Warning Tape :

a. Pigmented polyolefin, bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Thickness: **4 mil (0.1 mm)**.
d. Weight: **18.5 lb/1000 sq. ft (9.0 kg/100 sq. m)**.
e. Tensile in accordance with ASTM D882: **30 lbf (133.4 N)** and **2500 psi (17.2 MPa)**.

6. Reinforced Nonconducting Line-Warning Tape :

a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Thickness: **12 mil (0.3 mm)**.
d. Weight: **36.1 lb/1000 sq. ft (17.6 kg/100 sq. m)**.
e. Tensile in accordance with ASTM D882: **400 lbf (1780 N)** and **11,500 psi (79.2 MPa)**.

7. Detectable Line-Warning Tape :

a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Overall Thickness: **5 mil (0.125 mm)**.
d. Foil Core Thickness: **0.35 mil (8.9 m)**.
e. Weight: **28 lb/1000 sq. ft (13.7 kg/100 sq. m)**.
f. Tensile in accordance with ASTM D882: **70 lbf (311.3 N)** and **4600 psi (31.7 MPa)**.

8. Reinforced Detectable Line-Warning Tape :

    a. Reinforced, detectable three-layer laminate, consisting of printed pigmented woven scrim, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright-colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
    b. Width: **3 inch (75 mm)**.
    c. Overall Thickness: **8 mil (0.2 mm)**.
    d. Foil Core Thickness: **0.35 mil (8.9 m)**.
    e. Weight: **34 lb/1000 sq. ft (16.6 kg/100 sq. m)**.
    f. Tensile in accordance with ASTM D882: **300 lbf (1334 N)** and **12,500 psi (86.1 MPa)**.

F. Concrete Cable Route Markers :

1. Description: Concrete markers visually aid tracing the route of electrical cables. Monument markers are typically installed at grade. Protective cover markers are typically installed above the cables at grade or below grade.
2. Product Characteristics:

    a. Material: Precast reinforced concrete.
    b. Marker Type:

        1) Above-Ground Monument Post:

            a) Nominal Dimensions (Height, Width, Depth): **30 inch (760 mm)**, **6 inch (150 mm)**, **3 inch (75 mm)**.

        2) Above-Ground Monument Block:

            a) Nominal Dimensions (Height, Width, Depth): [**12 inch (300 mm)**, **12 inch (300 mm)**, **6 inch (150 mm)**][**24 inch (600 mm)**, **24 inch (600 mm)**, **4 inch (100 mm)**].

        3) In-Ground Protective Cover (Plank or Slab):

            a) Nominal Dimensions (Length, Width, Depth): [**36 inch (914 mm)**, **6 inch (150 mm)**, **2 inch (50 mm)**][**36 inch (914 mm)**, **9 inch (230 mm)**, **2 inch (50 mm)**][**12 inch (305 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**][**24 inch (610 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**][**36 inch (914 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**].

    c. Legend: [**"DANGER - ELECTRICITY"**][**"ELECTRIC CABLES"**][**"ELECTRIC SPLICE"**].
    d. Lettering: Approximately **1/8 inch (3 mm)** deep, not less than [**1 inch (25 mm)**][**1.5 inch (38 mm)**] high, symmetrically spaced; marked on both sides to allow for reversal.

3. Required Product Options:

    a. Color: [**Red**]<**Insert color**> dye added to concrete during batching.
    b. Attach metal medallion or sign stamped with [**feeder number**]<**Insert required information**>.

G. Stenciled Legend: In nonfading, waterproof, [**black**]<**Insert color**> ink or paint. Minimum letter height must be [**1 inch (25 mm)**]<**Insert dimension**>.

2.5 TAGS

A. Metal Tags: Brass or aluminum, **2 by 2 by 0.05 inch (50 by 50 by 1.3 mm)**, with stamped legend, punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

B. Nonmetallic Preprinted Tags: Polyethylene tags, [**0.015 inch (0.38 mm)**][**0.023 inch (0.58 mm)**] thick, color-coded for phase and voltage level, with factory [**screened**][**printed**] permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Grafoplast Wire Markers**]
e. [**LEM Products Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. [**Seton Identification Products; a Brady Corporation company**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Grafoplast Wire Markers**]

e. [**LEM Products Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. [**Seton Identification Products; a Brady Corporation company**]
i. <**Insert manufacturer's name**>

C. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**LEM Products Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**LEM Products Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

3. Polyester Tags: [**0.010 inch (0.25 mm)**][**0.015 inch (0.38 mm)**]<**Insert dimension**> thick, with corrosion-resistant grommet and cable tie for attachment.
4. Marker for Tags:

a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.6 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**emedco**]
e. [**Marking Services Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Brady Corporation**]
    b. [**Carlton Industries, LP**]
    c. [**Champion America**]
    d. [**emedco**]
    e. [**Marking Services Inc.**]
    f. <**Insert manufacturer's name**>

3. Preprinted aluminum signs, [**high-intensity reflective,**]punched or drilled for fasteners, with colors, legend, and size required for application.
4. **1/4 inch (6.4 mm)** grommets in corners for mounting.
5. Nominal Size: **7 by 10 inch (180 by 250 mm)**.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Brady Corporation**]
    b. [**Champion America**]
    c. [**emedco**]
    d. [**Marking Services Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Brady Corporation**]
    b. [**Champion America**]
    c. [**emedco**]
    d. [**Marking Services Inc.**]
    e. <**Insert manufacturer's name**>

3. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with **0.0396 inch (1 mm)** galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
4. **1/4 inch (6.4 mm)** grommets in corners for mounting.
5. Nominal Size: **10 by 14 inch (250 by 360 mm)**.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Brady Corporation**]
    b. [**Carlton Industries, LP**]
    c. [**emedco**]

d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

3. Engraved legend.
4. Thickness:

a. For signs up to **20 sq. inch (129 sq. cm)**, minimum **1/16 inch (1.6 mm)** thick.
b. For signs larger than **20 sq. inch (129 sq. cm)**, **1/8 inch (3.2 mm)** thick.
c. Engraved legend with [**black letters on white face**][**white letters on dark gray background**]<**Insert colors**>.
d. [**Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting**][**Self-adhesive**].
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**HellermannTyton**]
2. [**Ideal Industries, Inc.**]
3. [**Marking Services Inc.**]
4. [**Panduit Corp**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**HellermannTyton**]
2. [**Ideal Industries, Inc.**]
3. [**Marking Services Inc.**]
4. [**Panduit Corp**]
5. <**Insert manufacturer's name**>

C. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.

D. UL ZODZ - General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and

Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black, except where used for color-coding.

E. UL ZODZ - UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black.

F. UL ZODZ - Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **7000 psi (48.2 MPa)**.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: **Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C)**.
5. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection[**and fire-alarm**] equipment[**, including raceways,**] must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than [**7.7 ft (2.3 m)**]<**Insert height**> above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1[**and IEEE C2**].

C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded [**service**][**feeder**][**and**][**branch-circuit**] conductors.

1. Color must be factory applied[**or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction**].
2. Colors for 208Y/120 V Circuits:

    a. Phase A: Black.

b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 240 V Circuits:

a. Phase A: Black.
b. Phase B: Red.

4. Colors for 480Y/277 V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

5. Color for Neutral (Grounded Conductor): [**White**][**or**][**gray**].
6. Color for Equipment Ground: [**Bare copper**][**Green**][**Green with yellow stripe**].
7. Color for Isolated Ground: Green with two or more yellow stripes.

D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.

E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

F. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."
4. <**Insert name**>.

G. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

H. Locations of Underground Lines: Underground-line warning tape for power and lighting.

I. Vaults, Manholes, Handholes, and Pull and Junction Boxes, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**write-on tags**][**nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation**].

J. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with **3 inch (75 mm)** high, black letters on **20 inch (500 mm)** centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at [**10 ft (3 m)**][**30 ft (9 m)**] maximum intervals.
2. Identify system voltage[**and system or service type**] with black letters on orange field.
3. Apply floor marking tape to the following finished surfaces:

a. Floor surface directly above conduits running beneath and within **12 inch (300 mm)** of floor that is in contact with earth or is framed above unexcavated space.
b. Wall surfaces directly external to raceways concealed within wall.
c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Accessible Raceways, Armored and Metal-Clad Cables, More Than 1000 V: [**Vinyl wraparound labels**][**Snap-around labels**][**Self-adhesive labels**][**Snap-around color-coding bands for raceway and cables**].

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with black letters on orange field.

L. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**vinyl wraparound labels**][**self-adhesive wraparound labels**][**snap-around labels**][**snap-around color-coding bands**][**self-adhesive vinyl tape**] to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with [**black letters on orange field**]<**Insert color scheme**>.

M. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than [**30**]<**Insert number**> A and [**120**]<**Insert number**> V to Ground: Identify with self-adhesive [**raceway labels**][**vinyl tape applied in bands**].

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with [**black letters on orange field**]<**Insert color scheme**>.

N. Conductors to Be Extended in Future: Attach [**write-on tags**][**marker tape**] to conductors[**and list source**].

O. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:

1. Panelboard designation.
2. Colon or dash.
3. Branch circuit number.

P. Workspace Indication: Apply [**floor marking tape**][**or**][**tape and stencil**] to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

Q. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: [**Self-adhesive label**][**Baked-enamel signs**][**Metal-backed butyrate signs**][**Laminated acrylic or melamine plastic sign**].
3. Outdoor Equipment: [**Laminated acrylic or melamine sign**][**Stenciled legend 4 inch (100 mm) high**].
4. Equipment to Be Labeled:

    a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels[**containing equipment designation**].
    b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of [**self-adhesive,**

engraved,][**engraved,**] laminated acrylic or melamine label.

c. Enclosures and electrical cabinets.
d. Access doors and panels for concealed electrical items.
e. Switchgear.
f. Switchboards.
g. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
h. Substations.
i. Emergency system boxes and enclosures.
j. Motor-control centers.
k. Enclosed switches.
l. Enclosed circuit breakers.
m. Enclosed controllers.
n. Variable-speed controllers.
o. Push-button stations.
p. Power-transfer equipment.
q. Contactors.
r. Remote-controlled switches, dimmer modules, and control devices.
s. Uninterruptible power supplies.
t. Battery-inverter units.
u. Battery racks.
v. Power-generating units.
w. Monitoring and control equipment.
x. <**Insert equipment**>.

R. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with [**NFPA 70E**][**and**][**Section 260573 "Power System Studies"**] requirements for arc-flash hazard warning labels.
2. Raceways and Cables Carrying Circuits at More Than 1000 V:

a. Black letters on orange field.
b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

5. <**Insert names and wording of warning signs or labels (for example, multiple services and voltages, and others**>.

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**].

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

   a. Power-transfer switches.
   b. Controls with external control power connections.
   c. <**Insert items**>.

E. Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**].

F. Emergency Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**] with white legend on red background with minimum **3/8 inch (10 mm)** high letters for emergency instructions at equipment used for [**power transfer**][**load shedding**]<**Insert emergency operations**>.

3.4 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.5 INSTALLATION

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 018116 "Facility Environmental Requirements" and Section 260010 "Supplemental Requirements for Electrical."

C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

F. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Verify identity of item before installing identification products.

H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

I. Apply identification devices to surfaces that require finish after completing finish work.

J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of **6 inch (150 mm)** where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

U. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape not less than **12 inch (300 mm)** directly above cables or raceways buried **18 inch (450 mm)** or more below grade. Use multiple tapes where width of multiple lines installed in common trench [**or concrete envelope**]exceeds **16 inch (400 mm)** overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

V. Concrete Cable Route Markers: [**As indicated on Drawings**]<**Insert Project-specific requirements**>.

W. Metal Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

X. Nonmetallic Preprinted Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

Y. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

Z. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

AA. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

BB. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 26 05 53 00

Task	Specification	Specification Description
26 05 53 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 83 00	26 05 13 00	Medium-Voltage Cables
26 05 83 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 83 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 00 00 00MOD000	26 01 00 00	Supplemental Requirements for Electrical

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Task	Specification	Specification Description
31 05 13 00	31 20 00 00	Earth Moving
31 05 13 00	33 46 00 00	Subdrainage
31 05 16 00	31 20 00 00	Earth Moving
31 05 16 00	33 46 00 00	Subdrainage
31 08 13 00	31 62 13 00	Concrete Piles
31 08 13 00	31 62 16 00	Steel Piles
31 08 13 00	31 62 19 00	Timber Piles

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SECTION 31 10 00 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and [**removing site utilities**][**abandoning site utilities in place**].
8. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.2 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than **2 inches (50 mm)** in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and [**indicated on Drawings**][**indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection."**]<**Insert requirement**>.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.6 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property

adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises[**where indicated**]<**Insert location**>.

D. Utility Locator Service: Notify [**utility locator service**][**Miss Utility**][**Call Before You Dig**][**Dig Safe System**][**One Call**]<**Insert name**> for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control[**and plant-protection**] measures are in place.

F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with [**MPI #23 (surface-tolerant, anticorrosive metal primer)**][**or**][**SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating**]<**Insert requirement**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion-

and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed[**or abandoned in place**].

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than [**two**]<**Insert number**> days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> in diameter, obstructions, and debris to a depth of [18 inches (450 mm)]<**Insert dimension**> below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and [**stockpile in areas approved by Architect**][**dispose of off-site**]<**Insert requirement**>.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth [**indicated on Drawings**][**of 6 inches (150 mm)**]<**Insert requirement**> in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to [72 inches (1800 mm)]<**Insert dimension**>.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 STOCKPILING ROCK

A. Remove from [**area indicated on Drawings**][**construction area**]<**Insert requirement**> naturally formed rocks that measure more than [1 foot (300 mm)]<**Insert dimension**> across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock [**where indicated on Drawings**][**away from edge of excavations**]<**Insert requirement**> without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to [36 inches (900 mm)]<**Insert dimension**>.
2. Do not stockpile rock within protection zones.
3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus rock to allow later use by the Owner.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00 00

Task	Specification	Specification Description
31 11 00 00	31 10 00 00	Site Clearing
31 13 00 00	31 10 00 00	Site Clearing
31 13 13 00	31 10 00 00	Site Clearing
31 13 16 00	31 10 00 00	Site Clearing

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SECTION 31 20 00 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil materials.
2. Geotextiles.
3. Controlled low-strength material.
4. Geofoam.
5. Accessories.

B. Related Requirements:

1. [**Section 013200 "Construction Progress Documentation"**][**Section 013233 "Photographic Documentation"**] for recording preexcavation and earth-moving progress.
2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping [**and stockpiling**] topsoil, and removal of above- and below-grade improvements and utilities.
3. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
4. Section 316329 "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.
5. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.2 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

B. Quantity allowances for earth moving are included in Section 012100 "Allowances."

C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

1. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
2. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
3. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
5. [**6 inches (150 mm)**]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
6. [**6 inches (150 mm)**]<**Insert dimension**> beneath pipe in trenches, and the greater of [**24 inches (600 mm)**]<**Insert dimension**> wider than pipe or [**42 inches (1065 mm)**]<**Insert dimension**> wide.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for in accordance with Contract provisions for [**unit prices**][**changes in the Work**] .
2. Bulk Excavation: Excavation more than [**10 ft. (3 m)**]<**Insert dimension**> in width and more than [**30 ft. (9 m)**]<**Insert dimension**> in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock:

1. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed [**1 cu. yd. (0.76 cu. m)**]<**Insert volume**> for bulk excavation or [**3/4 cu. yd. (0.57 cu. m)**]<**Insert volume**> for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

a. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a **42-inch- (1065-mm-)** maximum-width, short-tip-radius rock bucket; rated at not less than **138-hp (103-kW)** flywheel power with bucket-curling force of not less than **28,700 lbf (128 kN)** and stick-crowd force of not less than **18,400 lbf (82 kN)** with extra-long reach boom.
b. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than **230-hp (172-kW)** flywheel power and developing a minimum of **47,992-lbf (213.3-kN)** breakout force with a general-purpose bare bucket.

2. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material [**3/4 cu. yd. (0.57 cu. m)**]<**Insert volume**> or more in volume that exceed a standard penetration resistance of [**100 blows/2 inches (97 blows/50 mm)**]<**Insert value**> when tested by a geotechnical testing agency, in accordance with ASTM D1586/D1586M.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and

electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference [**at Project site**][**by web conference**]<**Insert location**> .

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: **12 by 12 inches (300 by 300 mm)**.
2. Warning Tape: **12 inches (300 mm)** long; of each color.

1.6 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each [**on-site**][**and**][**borrow**] soil material proposed for fill and backfill as follows:

1. Classification in accordance with ASTM D2487.
2. Laboratory compaction curve in accordance with [**ASTM D698**][**ASTM D1557**] .

B. Blasting plan [**approved by authorities having jurisdiction**] .

C. Seismic survey report from seismic survey agency.

D. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

E. Qualification Statements: For qualified testing agency.

1.7 QUALITY ASSURANCE

A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:

1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

C. Geotechnical Testing Agency Qualifications: Qualified in accordance with ASTM E329 and ASTM D3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify [**utility locator service**][**"Miss Utility"**][**"Call Before You Dig"**][**"Dig Safe System"**][**"One Call"**]<**Insert name**> for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in [**Section 015000 "Temporary Facilities and Controls"**][**and**][**Section 311000 "Site Clearing"**] are in place.

E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.

2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification [**Groups GW, GP, GM, SW, SP, and SM in accordance with ASTM D2487**][**Groups A-1, A-2-4, A-2-5, and A-3 in accordance with AASHTO M 145**] , or a combination of these groups; free of rock or gravel larger than [**3 inches (75 mm)**]<**Insert dimension**> in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: <**Insert value**> .
2. Plasticity Index: <**Insert value**> .

C. Unsatisfactory Soils: Soil Classification [**Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT in accordance with ASTM D2487**][**Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 in accordance with AASHTO M 145**] , or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 12 percent passing a **No. 200 (0.075-mm)** sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 8 percent passing a **No. 200 (0.075-mm)** sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 12 percent passing a **No. 200 (0.075-mm)** sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a **1-inch (25-mm)** sieve and not more than 8 percent passing a **No. 200 (0.075-mm)** sieve.

H. Drainage Course: Narrowly graded mixture of [**washed**] crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a **1-1/2-inch (37.5-mm)** sieve and zero to 5 percent passing a **No. 8 (2.36-mm)** sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a **1-inch (25-mm)** sieve and zero to 5 percent passing a **No. 4 (4.75-mm)** sieve.

J. Sand: ASTM C33/C33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

a. Class 2; AASHTO M 288.
b. As follows:

1) Grab Tensile Strength: **157 lbf (700 N)**; ASTM D4632/D4632M.
2) Sewn Seam Strength: **142 lbf (630 N)**; ASTM D4632/D4632M.
3) Tear Strength: **56 lbf (250 N)**; ASTM D4533.
4) Puncture Strength: **56 lbf (250 N)**; ASTM D4833/D4833M.

c. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.250-mm)**][**No. 70 (0.212-mm)**] sieve, maximum; ASTM D4751.
d. Permittivity: [**0.5**][**0.2**][**0.1**] per second, minimum; ASTM D4491/D4491M.
e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

a. Class 2; AASHTO M 288.
b. As follows:

1) Grab Tensile Strength: **247 lbf (1100 N)**; ASTM D4632/D4632M.
2) Sewn Seam Strength: **222 lbf (990 N)**; ASTM D4632/D4632M.
3) Tear Strength: **90 lbf (400 N)**; ASTM D4533/D4533M.
4) Puncture Strength: **90 lbf (400 N)**; ASTM D4833/D4833M.

c. Apparent Opening Size: **No. 60 (0.250-mm)** sieve, maximum; ASTM D4751.
d. Permittivity: 0.02 per second, minimum; ASTM D4491/D4491M.
e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting [**, cellular, low-density**] , flowable concrete material produced from the following:

1. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**][**or**][**Type III**] .
2. Fly Ash: ASTM C618, Class C or F.
3. Normal-Weight Aggregate: ASTM C33/C33M, [**3/4-inch (19-mm)**][**3/8-inch (10-mm)**]<**Insert dimension**> nominal maximum aggregate size.
4. Foaming Agent: ASTM C869/C869M.
5. Water: ASTM C94/C94M.
6. Air-Entraining Admixture: ASTM C260/C260M.

B. Produce cellular, low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: [**30 to 36 lb/cu. ft. (480 to 576 kg/cu. m)**][**36 to 42 lb/cu. ft. (576 to 675 kg/cu. m)**]<**Insert unit weight range**> at point of placement, when tested in accordance with ASTM C138/C138M.
2. Compressive Strength: [**80 psi (550 kPa)**][**140 psi (965 kPa)**]<**Insert value**> , when tested in accordance with ASTM C495/C495M.

C. Produce conventional-weight, controlled low-strength material with [**80-psi (550-kPa)**][**140-psi (965-kPa)**]<**Insert value**> compressive strength when tested in accordance with ASTM C495/C495M.

2.4 GEOFOAM

A. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.55-lb/cu. ft. (25-kg/cu. m) density, 25-psi (173-kPa) compressive strength**][**Type X, 1.30-lb/cu. ft. (21-kg/cu. m) density, 15-psi (104-kPa) compressive strength**][**Type VI, 1.80-lb/cu. ft. (29-kg/cu. m) density, 40-psi (276-kPa) compressive strength**][**Type VII, 2.20-lb/cu. ft. (35-kg/cu. m) density, 60-psi (414-kPa) compressive strength**][**Type V, 3.00-lb/cu. ft. (48-kg/cu. m) density, 100-psi (690-kPa) compressive strength**] .

B. Molded-Polystyrene Board Insulation: ASTM C578, [**Type I, 0.90-lb/cu. ft. (15-kg/cu. m) density, 10-psi (69-kPa) compressive strength**][**Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) density, 13-psi (90-kPa) compressive strength**][**Type II, 1.35-lb/cu. ft. (22-kg/cu. m) density, 15-psi (104-kPa) compressive strength**] .

1. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.

C. Rigid Cellular Polystyrene Geofoam: ASTM D6817/D6817M, [**Type EPS 19, 1.15-lb/cu. ft. (18.4-kg/cu. m) density, 5.8-psi (40-kPa) compressive strength at 1 percent deformation; 16-psi (110-kPa) compressive strength at 10 percent deformation**][**Type EPS 39, 2.40-lb/cu. ft. (38.4-kg/cu. m) density, 15-psi (103-kPa) compressive strength at 1 percent deformation; 40-psi (276-kPa) compressive strength at 10 percent deformation**]<**Insert requirement**> .

D. Connectors: [**Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors**][**Deformed steel reinforcing bars, 3/4 inch (19 mm) in diameter**]<**Insert requirement**> .

2.5 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.

4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXPLOSIVES

A. Explosives:

1. Do not use explosives.
2. Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

    a. Perform blasting without damaging adjacent structures, property, or site improvements.
    b. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
    b. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
    c. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. [**6 inches (150 mm)**]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
    f. [**6 inches (150 mm)**]<**Insert dimension**> beneath pipe in trenches and the greater of [**24 inches (600 mm)**]<**Insert dimension**> wider than pipe or [**42 inches (1065 mm)**]<**Insert dimension**> wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation in accordance with unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
    b. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
    c. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.

e. [**6 inches (150 mm)**]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
f. [**6 inches (150 mm)**]<**Insert dimension**> beneath pipe in trenches and the greater of [**24 inches (600 mm)**]<**Insert dimension**> wider than pipe or [**42 inches (1065 mm)**]<**Insert dimension**> wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus **1 inch (25 mm)**. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations **6 to 12 inches (150 to 300 mm)** above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus **1 inch (25 mm)**. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots in accordance with requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to **12 inches (300 mm)** higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: [**12 inches (300 mm) each side of pipe or conduit**][**As indicated**] .

C. Trench Bottoms:

1. Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints,

fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

a. For pipes and conduit less than **6 inches (150 mm)** in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
b. For pipes and conduit **6 inches (150 mm)** or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
c. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
d. Excavate trenches **6 inches (150 mm)** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

2. Excavate trenches **4 inches (100 mm)** deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

a. Excavate trenches **6 inches (150 mm)** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots in accordance with requirements in Section 015639 "Temporary Tree and Plant Protection."

3.8 EXCAVATION FOR ELEVATOR CYLINDER

A. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in [**Section 142400 "Hydraulic Elevators."**][**Section 142413 "Hydraulic Freight Elevators."**]

B. Provide well casing as necessary to retain walls of well hole.

3.9 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade [**below the building slabs and pavements**]<**Insert locations**> with a pneumatic-tired [**and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes)**]<**Insert requirement**> to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction [**, repeating proof-rolling in direction perpendicular to first direction**] . Limit vehicle speed to **3 mph (5 km/h)**.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for in accordance with Contract provisions for [**unit prices**][**changes in the Work**] .

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.10 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of **2500 psi (17.2 MPa)**, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.13 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within [**18 inches (450 mm)**]<**Insert dimension**> of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide [**4-inch- (100-mm-)**]<**Insert dimension**> thick, concrete-base slab

support for piping or conduit less than [30 inches (750 mm)]<**Insert dimension**> below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of [4 inches (100 mm)]<**Insert dimension**> of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of [**subbase material**][**satisfactory soil**] , free of particles larger than [1 inch (25 mm)]<**Insert dimension**> in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.

    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.14 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.15 GEOFOAM FILL

A. Place a leveling course of sand, [2 inches (50 mm)]<**Insert dimension**> thick, over subgrade. Finish leveling course to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

1. Place leveling course on subgrades free of mud, frost, snow, or ice.

B. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.

C. Install geofoam connectors at each layer of geofoam to resist horizontal displacement in accordance with geofoam manufacturer's written instructions.

D. Cover geofoam with [**subdrainage**][**separation**] geotextile before placing overlying soil materials.

3.16 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.17 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than [**8 inches (200 mm)**]<**Insert dimension**> in loose depth for material compacted by heavy compaction equipment and not more than **4 inches (100 mm)** in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] :

1. Under structures, building slabs, steps, and pavements, scarify and recompact top **12 inches (300 mm)** of existing subgrade and each layer of backfill or fill soil material at [**95**]<**Insert number**> percent.
2. Under walkways, scarify and recompact top **6 inches (150 mm)** below subgrade and compact each layer of backfill or fill soil material at [**92**]<**Insert number**> percent.
3. Under turf or unpaved areas, scarify and recompact top **6 inches (150 mm)** below subgrade and compact each layer of backfill or fill soil material at [**85**]<**Insert number**> percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at [**85**]<**Insert number**> percent.

3.18 GRADING

A. Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus [**1 inch (25 mm)**]<**Insert dimension**> .
2. Walks: Plus or minus [**1 inch (25 mm)**]<**Insert dimension**> .
3. Pavements: Plus or minus [**1/2 inch (13 mm)**]<**Insert dimension**> .

C. Grading inside Building Lines: Finish subgrade to a tolerance of [1/2 inch (13 mm)]<**Insert dimension**> when tested with a 10-foot (3-m) straightedge.

3.19 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer [**to 85 percent of maximum dry unit weight in accordance with ASTM D698**][**with a minimum of two passes of a plate-type vibratory compactor**] .

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer [**to 85 percent of maximum dry unit weight in accordance with ASTM D698**][**with a minimum of two passes of a plate-type vibratory compactor**] .
2. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.

3.20 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course [**and base course**] on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course [**and base course**] under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade in accordance with manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course [**and base course**] to required crown elevations and cross-slope grades.
4. Place subbase course [**and base course**] 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course [**and base course**] that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
6. Compact subbase course [**and base course**] at optimum moisture content to required grades, lines, cross sections, and thickness to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] .

C. Pavement Shoulders: Place shoulders along edges of subbase course [**and base course**] to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase [**and base**] layer to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] .

3.21 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade in accordance with manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course **6 inches (150 mm)** or less in compacted thickness in a single layer.
3. Place drainage course that exceeds **6 inches (150 mm)** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches (150 mm)** thick or less than **3 inches (75 mm)** thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with ASTM D698.

3.22 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Compaction Testing: Testing agency will test compaction of soils in place in accordance with ASTM D1556/D15556M, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every [**2000 sq. ft. (186 sq. m)**]<**Insert area**> or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every [**100 ft. (30 m)**]<**Insert dimension**> or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every [**150 ft. (46 m)**]<**Insert dimension**> or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.23 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.24 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00 00

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Task	Specification	Specification Description
31 22 00 00	31 20 00 00	Earth Moving
31 22 13 00	31 20 00 00	Earth Moving
31 22 16 00	31 20 00 00	Earth Moving
31 22 16 13	31 20 00 00	Earth Moving
31 22 19 00	31 20 00 00	Earth Moving
31 22 19 13	31 20 00 00	Earth Moving
31 23 00 00	31 20 00 00	Earth Moving
31 23 16 00	31 20 00 00	Earth Moving
31 23 16 13	31 20 00 00	Earth Moving

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SECTION 31 23 16 16 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain-link fence framework.
2. Chain-link fence fabric.
3. Chain-link fittings.
4. Chain-link wires and ties.
5. Chain-link swing gates.
6. Chain-link horizontal-slide gates.
7. Gate operators and controls.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete for post footings[**and equipment bases/pads for gate operators and controls**].
2. Section 281500 "Integrated Access Control Hardware Devices" for gate controls.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Inspect and discuss [**electrical roughing-in,**] equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of gate operator.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.
5. <**Insert requirement**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
b. Fence [**and gate**] posts, rails, and fittings.
c. Chain-link fabric, reinforcements, [**gate types, hardware,**] and attachments.
d. Accessories: [**Privacy slats**][**Barbed wire**][**Barbed tape**]<**Insert item**>.
e. Gates and hardware.
f. Gate operators, including operating instructions and motor characteristics.

B. Shop Drawings: For each type of fence [**and gate**] assembly.

1. Include plans, elevations, sections, ground details, [**mounting,**] post spacing, and attachments to

other work.
2. Include accessories, hardware, gate operation, and operational clearances.
3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1. Polymer-Coated Components: In **6-inch (150-mm)** lengths for components and on full-sized units for accessories.

E. Delegated Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**professional engineer**][**testing agency**][**factory-authorized service representative**].

B. Product Certificates: For each type of chain-link fence,[**operator,**] and gate.

C. Product Test Reports: For framework strength in accordance with ASTM F1043, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**or**][**a qualified testing agency**].

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: In accordance with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

C. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup for typical chain-link fence[**and gate**], including accessories.

a. Size: [10 ft. (3 m)]<**Insert dimension**> length of fence.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**] to repair or replace components of fences[**, gates, operators, and controls**] that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gate operators and controls.
d. <**Insert failure modes**>.

2. Warranty Period: [**Five**][**15**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks are to withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. Design Wind Load: [**As indicated on Drawings**]<**Insert loads**>.

a. Minimum Post Size: Determine in accordance with ASTM F1043 for post spacing not to exceed [10 feet (3 m)]<**Insert dimension**> for Material [**Group IA, ASTM F1043, Schedule 40 steel pipe**][**Group IC, electric-resistance-welded round steel pipe**]<**Insert material group**>.
b. Minimum Post Size and Maximum Spacing: Determine in accordance with CLFMI WLG 2445, based on mesh size and pattern specified.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

D. Accessibility: Pedestrian gates to comply with the United States Access Board's ADA-ABA Accessibility Guidelines.

2.2 CHAIN-LINK FENCES, GENERAL

A. CLFMI Publications: Comply with the CLFMI Product Manual unless modified by requirements in the

Contract Documents.

B. Chain-Link Fence and Gate Assemblies: Include materials applicable for a complete assembly of application types, consisting of commercial, industrial, and security chain-link fences and gates.

1. Source Limitations: Obtain chain-link fence and gate components from single source or manufacturer.

2.3 CHAIN-LINK FENCE FRAMEWORK

A. Posts and Rails <**Insert drawing designation**>: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thicknesses in accordance with ASTM F1043[**or ASTM F1083**] based on the following:

1. Fence Height: [**72 inches (1830 mm)**][**96 inches (2440 mm)**][**As indicated on Drawings**]<**Insert dimension**>.
2. Light-Industrial-Strength Material: [**Group IC-L, round steel pipe, electric-resistance-welded pipe**][**Group II-L, roll-formed-steel C-section shapes**][**Group III-L, hot-rolled H-beam shapes**][**Group IV, Alternative Design**].

    a. Line Post: [**1.9 inches (48 mm) in diameter**][**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**2.25 by 1.7 inches (57 by 43 mm)**]<**Insert dimension(s)**>.
    b. End, Corner, and Pull Posts: [**2.375 inches (60 mm)**][**2.875 inches (73 mm)**][**4.0 inches (102 mm)**][**2.25 by 1.7 inches (57 by 43 mm)**]<**Insert dimension(s)**>.

3. Heavy-Industrial-Strength Material: [**Group IA, round steel pipe, Schedule 40**][**Group IC, round steel pipe, electric-resistance-welded pipe**][**Group II, roll-formed-steel C-section shapes**][**Group III, hot-rolled H-beam shapes**][**Group IV, Alternative Design**].

    a. Line Post: [**1.9 inches (48 mm) in diameter**][**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**4.0 inches (102 mm) in diameter**][**6.625 inches (168 mm) in diameter**][**1.875 by 1.63 inches (48 by 41 mm)**][**2.25 by 1.70 inches (57 by 43 mm)**][**3.25 by 2.50 inches (83 by 64 mm)**]<**Insert dimension(s)**>.
    b. End, Corner, and Pull Posts: [**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**4.0 inches (102 mm) in diameter**][**6.625 inches (168 mm) in diameter**][**2.25 by 1.70 inches (57 by 43 mm)**][**3.25 by 2.50 inches (83 by 64 mm)**]<**Insert dimension(s)**>.

4. Horizontal Framework Members: [**Intermediate**][**top**][**and**][**bottom**] rails in accordance with ASTM F1043.

    a. Top Rail: [**1.66 inches (42 mm) in diameter**][**1.25 by 1.63 inches (32 by 41 mm)**]<**Insert dimension(s)**>.

5. Brace Rails: ASTM F1043.
6. Metallic Coating for Steel Framework:

    a. Type A: Not less than minimum **2.0 oz./sq. ft. (0.61 kg/sq. m)** average zinc coating in accordance with ASTM A123/A123M or **4.0 oz./sq. ft. (1.22 kg/sq. m)** zinc coating in accordance with ASTM A653/A653M.
    b. Type B: Zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq. ft. (0.27 kg/sq. m)** of zinc after welding, a chromate conversion coating, and a clear, verifiable

polymer film.

c. External, Type B: Zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq. ft. (0.27 kg/sq. m)** of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than **0.3-mil- (0.0076-mm-)** thick, zinc-pigmented coating.

d. Type C: Zn-5-Al-MM alloy, consisting of not less than **1.8 oz./sq. ft. (0.55 kg/sq. m)** coating.

e. Coatings: Any coating above.

7. Polymer coating over metallic coating.

a. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

2.4 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist in accordance with "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: <**Insert dimension**>[**As indicated on Drawings**].
2. Steel Wire for Fabric: Wire diameter of [**0.192 inch (4.88 mm)**][**0.148 inch (3.76 mm)**][**0.120 inch (3.05 mm)**][**0.113 inch (2.87 mm)**]<**Insert dimension**>.

a. Mesh Size: [**2-1/8 inches (54 mm)**][**2 inches (50 mm)**][**1-3/4 inches (44 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

b. Aluminum-Coated Fabric: ASTM A491, Type I, [**0.40 oz./sq. ft. (122 g/sq. m)**][**0.35 oz./sq. ft. (107 g/sq. m)**][**0.30 oz./sq. ft. (92 g/sq. m)**].

c. Zinc-Coated Fabric: ASTM A392, Type II, [**Class 1, 1.2 oz./sq. ft. (366 g/sq. m)**][**Class 2, 2.0 oz./sq. ft. (610 g/sq. m)**] with zinc coating applied [**before**][**after**] weaving.

d. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F1345, Type III, [**Class 1, 0.60 oz./sq. ft. (183 g/sq. m)**][**Class 2, 1.0 oz./sq. ft. (305 g/sq. m)**].

e. Polymer-Coated Fabric: ASTM F668, [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

1) Color: [**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

f. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Aluminum Wire Fabric: ASTM F1183, with [**mill**][**caustic-cleaned or etched**] finish, and wire diameter of [**0.148 inch (3.76 mm)**][**0.192 inch (4.88 mm)**].

a. Mesh Size: [**2 inches (50 mm)**][**1 inch (25 mm)**].

4. Selvage: [**Knuckled at both selvages**][**Twisted top and knuckled bottom**].

2.5 CHAIN-LINK FITTINGS

A. Provide fittings in accordance with ASTM F626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: [**Pressed-steel or round-steel tubing**][**Aluminum Alloy 6063**] not less than **6 inches (152 mm)** long.
2. Rail Clamps: Line and corner boulevard clamps for connecting [**intermediate**][**and**][**bottom**] rails to posts.

E. Tension and Brace Bands: [**Pressed steel**][**Aluminum Alloy 6063**].

F. Tension Bars: [**Steel**][**Aluminum**][**Fiberglass**], length not less than **2 inches (50 mm)** shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: [**Steel, hot-dip galvanized after threading**][**Mill-finished aluminum**] rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: [**Pressed steel or cast iron**][**Aluminum**], with clips, slots, or other means for attaching strands of barbed wire[**, and means for attaching to posts**][**, integral with post cap**], for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: [**Type I, slanted arm**][**Type II, vertical arm**].
4. Double-Arm Type: [**Type III, V-shaped arm**][**Type IV, A-shaped arm**].

I. Tie Wires, Clips, and Fasteners: In accordance with ASTM F626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, in accordance with the following:

a. Hot-Dip Galvanized Steel: [**0.106-inch- (2.69-mm-)**][**0.148-inch- (3.76-mm-)**] diameter wire[**; galvanized coating thickness matching coating thickness of chain-link fence fabric**].
b. Aluminum: ASTM B211/B211M; Alloy 1350-H19; [**0.148-inch- (3.76-mm-)**][**0.192-inch- (4.88-mm-)**] diameter, mill-finished wire.

J. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than **1.2 oz./sq. ft. (366 g/sq. m)** of zinc.

a. Polymer coating over metallic coating.

2. Aluminum: Mill finish.

2.6 CHAIN-LINK WIRE AND TIES

A. Metallic-Coated Steel Wire: **0.177-inch- (4.5-mm-)** diameter, marcelled tension wire in accordance with ASTM A817 or ASTM A824, with the following metallic coating:

1. Type I: Aluminum coated (aluminized).
2. Type II: Zinc coated (galvanized) by [**hot-dip**][**electrolytic**] process, with the following minimum coating weight:

    a. Class 3: Not less than **0.8 oz./sq. ft. (244 g/sq. m)** of uncoated wire surface.
    b. Class 4: Not less than **1.2 oz./sq. ft. (366 g/sq. m)** of uncoated wire surface.
    c. Class 5: Not less than **2 oz./sq. ft. (610 g/sq. m)** of uncoated wire surface.
    d. Matching chain-link fabric coating weight.

3. Type III: Zn-5-Al-MM alloy with the following minimum coating weight:

    a. Class 60: Not less than **0.6 oz./sq. ft. (183 g/sq. m)** of uncoated wire surface.
    b. Class 100: Not less than **1 oz./sq. ft. (305 g/sq. m)** of uncoated wire surface.
    c. Matching chain-link fabric coating weight.

B. Polymer-Coated Steel Wire: [**0.177-inch- (4.5-mm-)**][**0.148-inch- (3.8-mm-)**] diameter, tension wire in accordance with ASTM F1664, [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

1. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

C. Aluminum Wire: **0.192-inch- (4.88-mm-)** diameter tension wire, mill finished, in accordance with **ASTM B211 (ASTM B211M)**, Alloy 6061-T94 with **50,000-psi (344-MPa)** minimum tensile strength.

2.7 CHAIN-LINK SWING GATES

A. General: ASTM F900 for gate posts and [**single**][**double**] swing gate types.[**Provide automated vehicular gates in accordance with ASTM F2200.**]

1. Gate Leaf Width: [**36 inches (914 mm)**][**As indicated**]<**Insert width**>.
2. Framework Member Sizes and Strength: Based on gate fabric height [**of 72 inches (1830 mm) or less**][**of more than 72 inches (1830 mm)**][**as indicated**]<**Insert dimension**>.

B. Swing Gate Pipe and Tubing:

1. Swing Gate Posts: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].
2. Gate Frames and Bracing: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].
3. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; [**protective coating and finish to match fence framework**][**manufacturer's standard protective coating and finish**]<**Insert finish**>.
4. Aluminum: ASTM B429/B429M; [**mill**][**manufacturer's standard**]<**Insert finish**> finish.

C. Swing Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**].

D. Swing Gate Extended Posts and Frame Members: Fabricate gate posts and frame end members to extend [**12 inches (300 mm)**][**as indicated**]<**Insert dimension**> above top of chain-link fabric at both ends of gate frame to attach barbed [**wire**][**tape**] assemblies.

E. Swing Gate Hardware:

1. Hinges: [**180-degree inward**][**180-degree outward**][**360-degree inward and outward**] swing.
2. Latch: Permitting operation from both sides of gate[**with provision for padlocking accessible from both sides of gate**].

3. Lock: [**Manufacturer's standard**]<**Insert requirement**> internal device.
4. Padlock and Chain: <**Insert requirements**>.
5. Closer: [**Manufacturer's standard**]<**Insert requirement**>.
6. <**Insert hardware items and accessories**>.

2.8 CHAIN-LINK HORIZONTAL-SLIDE GATES

A. Chain-Link Horizontal-Slide Gates: ASTM F1184 for gate posts and [**single**][**double**] sliding gate types for [**pedestrian**][**and**][**vehicle**] assembly.[**Provide automated vehicular gates in accordance with ASTM F2200.**]

1. Classification:

a. Type I Overhead Slide:

1) Gate Leaf Width: [**As indicated**]<**Insert width**>.
2) Framework Member Sizes and Strength: Based on gate fabric height [**of 72 inches (1830 mm) or less**][**of more than 72 inches (1830 mm)**][**as indicated**]<**Insert dimension**>.

b. Type II Cantilever Slide, [**Class 1 with external**][**Class 2 with internal**] roller assemblies:

1) Slide Gate Frame Width and Height: [**48 inches (1220 mm) wide or less by 72 inches (1830 mm) high or less**][**More than 48 inches (1220 mm) wide by any height**][**As indicated**]<**Insert dimension**>.

B. Slide Gate Pipe and Tubing Finish:

1. Zinc-Coated Steel: [**Protective coating and finish to match fence framework**][**Manufacturer's standard protective coating and finish**]<**Insert finish**>.
2. Aluminum: ASTM B429/B429M; [**mill**][**manufacturer's standard**]<**Insert finish**> finish.
3. Sliding Gate Posts: ASTM F1184. Provide [**round tubular steel**][**rectangular tubular steel**][**round tubular aluminum**][**rectangular tubular aluminum**] posts.
4. Sliding Gate Frames and Bracing: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].

C. Slide Gate Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**].

D. Slide Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame [**12 inches (300 mm)**][**as indicated**]<**Insert dimension**> as required to attach barbed [**wire**][**tape**] assemblies.

E. Overhead Track Assembly: Manufacturer's standard track, with overhead framework supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

F. Slide Gate Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from [**galvanized steel**][**galvanized malleable iron**][**mill-finished Grade 319 aluminum-alloy casting with stainless steel fasteners**].
2. Latch: Permitting operation from both sides of gate[**with provision for padlocking accessible from both sides of gate**].
3. Lock: [**Manufacturer's standard**]<**Insert requirement**> internal device.

4. Padlock and Chain: <**Insert requirements**>.
5. <**Insert hardware items and accessories**>.

2.9 ACCESSORIES

A. Privacy Slats:

1. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than **0.06 inch (1.5 mm)** thick, sized to fit mesh specified for direction indicated[**, with vandal-resistant fasteners and lock strips**].
2. Tubular Polyethylene Slats: Minimum **0.023-inch (0.58-mm)**-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with [**vandal-resistant fasteners and lock strips**][**fins for increased privacy factor**].
3. Aluminum Slats: Minimum **0.01-inch (0.25-mm)**-thick aluminum, sized to fit mesh specified for direction indicated.
4. Redwood Slats: **5/16-inch (7.9-mm)**-thick redwood, sized to fit mesh specified for direction indicated.
5. Hedge-Type Slats: UV-light-stabilized[**, flame-resistant**], PVC "needles" woven into braided, galvanized wire core, sized to fit mesh specified for direction indicated.
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated on Drawings**]<**Insert color**>.

B. Barbed Wire:

1. Steel Barbed Wire: ASTM A121, two-strand barbed wire, **0.099-inch- (2.51-mm-)** diameter line wire with **0.080-inch- (2.03-mm-)** diameter, four-point round barbs spaced not more than **5 inches (127 mm)** o.c.

    a. Aluminum Coating: Type A.
    b. Zinc Coating: Type Z, Class 3.

2. Polymer-Coated, Galvanized-Steel Barbed Wire: ASTM F1665, two-strand barbed wire, **0.080-inch- (2.03-mm-)** diameter line wire with **0.080-inch- (2.03-mm-)** diameter, four-point, round [**aluminum alloy**][**galvanized-steel**] barbs spaced not more than **5 inches (127 mm)** o.c.

    a. Polymer Coating: [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

        1) Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**] in accordance with ASTM F934.

3. Barbed Tape:

    a. Wire-Reinforced Tape: ASTM F1910; continuous coils with four-point, needle-sharp barbs permanently cold clenched around a core wire.
    b. Core Wire: High-tensile-strength, [**zinc-coated steel**][**or**][**stainless steel**].
    c. Configuration: [**Single**][**Double**] coil.
    d. Style: [**Helical**][**Concertina**] pattern.
    e. Coil Diameter(s): [**18-inch (457-mm)**][**24 inches (610 mm)**][**24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil**][**As indicated on Drawings**]<**Insert diameter**>.
    f. Coil Loop Spacing(s): [**12 inches (300 mm)**][**Manufacturer's standard**][**As indicated on Drawings**]<**Insert spacing**>.

g. Barb Length Classification: [**Long, 1.2-inch (30.5-mm)**][**Medium, 0.4-inch (10.2-mm)**][**Short, 0.1875-inch (4.76-mm)**] barb.
h. Barb Spacing: [**4 inches (102 mm)**]<**Insert dimension**> o.c.
i. Barb Set: [**Straight**][**Offset**][**Manufacturer's standard**].

4. Clips: Stainless steel, **0.065 inch (1.7 mm)** thick by **0.375 inch (9.5 mm)** wide, capable of withstanding a minimum **150-lbf (667-N)** pull load to limit extension of coil, resulting in a concertina pattern when deployed.
5. Tie Wires: Stainless steel, **0.065 inch (1.7 mm)** in diameter.

C. Touch-up Paint: Liquid polymer for field coating with polymer coated fencing components as recommended by manufacturer.

2.10 GATE OPERATORS AND CONTROLS

A. Provide factory-assembled automatic operating system designed for [**pedestrian**][**and**][**vehicle**] gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with [**remote-control stations**], safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide [**UL 325 listed operators for swing gates**][**BHMA A156.19 listed operators for pedestrian gates**][**ASTM F2200 for automated vehicular gates**].

B. Comply with NFPA 70.

C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.

D. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

1. Voltage: [**110 V**][**220 V**][**24 V dc**][**NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected**]<**Insert voltage**>.
2. Phase: [**One**][**Polyphase**].
3. Enclosure: [**Open dripproof**][**Totally enclosed**][**Manufacturer's standard**].
4. Duty: Continuous duty at ambient temperature of **105 deg F (40 deg C)** and at altitude of **3300 ft. (1005 m)** above sea level.
5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

E. Gate Operators: [**Gate**][**Concrete base**][**Post**][**In-ground**] mounted and as follows:

1. Hydraulic Gate Operators: [**Swing**][**Slide**].

a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
b. Gate Speed: Minimum [**45 feet (13.7 m)**][**60 feet (18.2 m)**] per minute.
c. Maximum Gate Weight: [**800 lb (363 kg)**]<**Insert value**>.
d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**Continuous duty**].
e. Hydraulic Fluid: Viscosity required for gate operation at ambient temperature range for Project.
f. Locking: Hydraulic in both directions.

2. Mechanical Gate Operators: [**Swing**][**Slide**].

    a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
    b. Gate Speed: Minimum [**45 feet (13.7 m) per minute**][**60 feet (18.2 m) per minute**][**variable speed**]<**Insert speed**>.
    c. Maximum Gate Weight: [**600 lb (272 kg)**][**800 lb (363 kg)**][**3000 lb (1360 kg)**]<**Insert value**>.
    d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**60 cycles per hour**][**Continuous duty**].
    e. Operating Type: [**Crank arm**][**Wheel-and-rail drive**][**Roller chain**].
    f. <**Insert feature**>.

F. Activation Controls: Electric controls separated from gate and motor and drive mechanism, with [**NEMA ICS 6, Type 1**][**NEMA ICS 6, Type 4**]<**Insert type of enclosure**> enclosure for [**surface**][**recessed or flush**][**concrete base**][**pedestal**]<**Insert mounting**> mounting, and with space for additional optional equipment. Provide the following remote-control device(s):

1. Control Station:

    a. Keyed, [**two**][**three**]-position switch with open[**, stop,**] and close function; located remotely from gate. Provide two keys per station.
    b. Momentary-contact, [**single**][**three**]-button-operated with open[**, stop,**] and close function; located remotely from gate.[**Key switch to lock out open and close buttons.**]
    c. <**Insert other type**>.

2. Card Reader: Functions only when authorized card is presented. Programmable, [**multiple**][**single**]-code system[**, permitting four different access periods**][**; face-lighted unit fully visible at night**].

    a. Reader Type: [**Touch plate**][**Swipe**][**Insertion**][**Proximity**].
    b. Card Reader Features:

        1) Usage Features: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].

3. <**Insert other reader type and features**>.
4. Digital Keypad Entry Unit: [**Programmable,**]multiple-code capability of not less than [**five**][**500**][**2500**]<**Insert number**> possible individual codes, consisting of [**1- to 7**][**4**][**5**]-digit codes[**, and permitting four different access periods**].
5. Face-lighted unit with [**metal-keyed**][**keyless-membrane**] keypad fully visible at night.
6. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide [**one**][**two**]<**Insert number**> programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than [**1000**][**10,000**]<**Insert number**> codes per channel configured for the following functions:

    a. Transmitters: [**Single**][**Three**]-button operated, with open [**and close**]function.
    b. Channel Settings: [**Two**][**Three**][**Four**]<**Insert number**> independent channel settings controlling separate receivers for operating more than one gate from each transmitter.

7. Telephone Entry System: Hands-free, voice-communication system for connection to building telephone system with digital-entry code activation of gate operator[**and auxiliary keypad entry**].

    a. Residential System: Designed to be wired to same line with telephone.
    b. Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to

access [**20**][**100**]<**Insert number**> telephones[**, and with electronic directory**].
c. <**Insert other system type and features**>.
d. Intercom System: <**Insert requirements**>.

G. Vehicle Sensing System: System includes automatic closing timer with adjustable time delay[**, timer cutoff switch,**] and loop detector designed to [**open and close gate**][**hold gate open until traffic clears**][**reverse gate**]<**Insert functions**>. System includes electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. System includes number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement, as recommended in writing by detection system manufacturer for function indicated, at location indicated on Drawings.

H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: [**Reverse gate in both opening and closing cycles and hold until clear of obstruction**][**Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction**].
2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as recommended by manufacturer.
4. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

I. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.

1. Type: [**Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge**][**Mechanical device, key, or crank-activated release**].

J. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features[**with capability for monitoring and auditing gate activity**]. Provide unit that is isolated from voltage spikes and surges.
2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
3. Master/Slave Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing[**and timer cutoff switch**].
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
8. Clock Timer: [**24-hour**][**Seven-day**]<**Insert time**> programmable for regular events.

K. Accessories:

1. Warning Module: [**Audio**][**Visual**], [**constant**][**strobe**]-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the United States Access Board's ADA-ABA Accessibility Guidelines.
2. Battery Backup System: Battery-powered drive and access-control system, independent of

primary drive system.

a. Fail-Safe: Gate opens and remains open until power is restored.
b. Fail-Secure: Gate cycles on battery power, then fail-safe when battery is drained.

3. External electric-powered [**solenoid**][**magnetic**] lock with delay timer allowing time for lock to release before gate operates.
4. [**Fire**][**Postal**] box.
5. Fire [**strobe**][**siren**] sensor.
6. Instructional, Safety, and Warning Labels and Signs: [**In accordance with UL 325**][**Manufacturer's standard for components and features specified**][**As indicated on Drawings**]<**Insert requirements**>.
7. Equipment Bases/Pads: Precast concrete, [**depth not less than 12 inches (305 mm)**]<**Insert depth**>, dimensioned and reinforced in accordance with gate operator component manufacturer's written instructions and as indicated on Drawings.

2.11 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.12 CONCRETE

A. Concrete Post Footings: Minimum 28-day compressive strength of **2500 psi (17.2 MPa)**.

2.13 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, **5/8 by 96 inches (16 by 2440 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for[**a certified survey of property lines and legal boundaries,**] site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by

Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of **500 feet (152 m)** or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION OF CHAIN-LINK FENCES

A. Install chain-link fencing in accordance with ASTM F567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts [**in concrete**][**with mechanical anchors**][**by mechanically driving into soil**] at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend **2 inches (50 mm)** above grade; shape and smooth to shed water.
    b. Concealed Concrete: Place top of concrete [**2 inches (50 mm)**]<**Insert dimension**> below grade [**as indicated on Drawings**]to allow covering with surface material.
    c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed in accordance with anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
    d. Posts Set into Holes in Concrete: Form or core drill holes not less than **5 inches (127 mm)** deep and **3/4 inch (20 mm)** larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed in accordance with anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3. Mechanically Driven Posts: Drive into soil to depth of [**30 inches (762 mm)**][**36 inches (914 mm)**]<**Insert dimension**>. Protect post top to prevent distortion.

D. Terminal Posts: Install terminal end, corner, and gate posts in accordance with ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of [**15 degrees or more**][**30 degrees or more**][**as indicated on Drawings**]<**Insert requirement**>. For runs exceeding **500 feet (152 m)**, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at [**96 inches (2440 mm)**][**10 feet (3 m)**]<**Insert dimension**> o.c.

F. Post Bracing and Intermediate Rails: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric **72 inches (1830 mm)** or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with **0.120-inch- (3.05-mm-)** diameter hog rings of same material and finish as fabric wire, spaced a maximum of **24 inches (610 mm)** o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along [**top**][**and**][**bottom**] of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within **6 inches (152 mm)** of bottom of fabric and tie to each post with not less than same diameter and type of wire.
2. Extended along top of [**barbed wire arms**][**extended posts**] and top of fence fabric to support barbed tape.
3. [**As indicated on Drawings**]<**Insert requirements**>.

H. Top Rail: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to [**outside**][**inside**] of enclosing framework. Leave [**1-inch (25-mm)**][**2-inch (50-mm)**] bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than **15 inches (380 mm)** o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric in accordance with ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at **12 inches (300 mm)** o.c. and to braces at **24 inches (610 mm)** o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.[**Peen ends of bolts or score threads to prevent removal of nuts.**]

N. Privacy Slats: Install slats in direction indicated, securely locked in place.

1. [**Vertically**][**Horizontally**][**, for privacy factor of 70 to 75**]<**Insert privacy factor range**>.
2. Diagonally[**for privacy factor of 80 to 85**]<**Insert privacy factor range**>.
3. Direction[**and privacy factor**] as indicated on Drawings.

O. Barbed Wire: Install barbed wire uniformly spaced[**, angled toward security side of fence**][**as indicated on Drawings**]. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

P. Barbed Tape: Install in accordance with ASTM F1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

3.4 INSTALLATION OF GATES

A. Install gates in accordance with manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 INSTALLATION OF GATE OPERATORS

A. Install gate operators in accordance with manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations in accordance with gate-operator component manufacturer's written instructions and as indicated.

C. Vehicle Loop Detector System: [**Cut grooves in pavement, bury, and seal**][**Bury**] wire loop in accordance with manufacturer's written instructions. Connect to equipment operated by detector.

D. Ground electric-powered motors, controls, and other devices in accordance with NFPA 70 and manufacturer's written instructions.

3.6 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence and Gate Grounding:

1. Ground for fence and fence posts is to be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of [**1500 feet (450 m)**]<**Insert dimension**>.
3. Fences within 100 ft. (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of [**750 ft. (225 m)**]<**Insert dimension**>.
4. Ground fence on each side of gates and other fence openings.

    a. Bond metal gates to gate posts.
    b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least **18 inches (457 mm)** below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of **150 feet (45 m)** on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground in accordance with IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is **6 inches**

(152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

F. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor in accordance with NFPA 780.

H. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.

1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Test and adjust operators, controls**[, alarms,]** and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Lubricate operator and related components.

C. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 31 23 16 16

Task	Specification	Specification Description
31 23 16 16	31 20 00 00	Earth Moving
31 23 16 26	31 20 00 00	Earth Moving
31 23 16 33	31 20 00 00	Earth Moving
31 23 16 36	31 20 00 00	Earth Moving

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SECTION 31 23 19 00 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction dewatering.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Section 015723 "Temporary Storm Water Pollution Control" for temporary storm water pollution controls mandated under the EPA's National Pollutant Discharge Elimination System.
3. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1. Dewatering observation wells are part of [**dewatering**]<**Insert description**> allowance.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered, including coordination with temporary erosion-control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.

4. Include written plan for dewatering operations, including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

B. Delegated Design Submittals: For dewatering system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Submittals:

1. Field quality-control reports.

B. Qualification Statements: For [**Installer**][**and**][**land surveyor**]<**Insert entity or specialist**>.

C. Delegated design engineer qualifications.

D. Existing Conditions: Using [**photographs**][**or**][**video recordings**], show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

E. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installer: An experienced installer that has specialized in [**design of dewatering systems and**]dewatering work.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.
3. Land Surveyor: A professional land surveyor who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located.

1.7 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering in accordance with the performance requirements.
2. The geotechnical report is [**included**][**referenced**] elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design dewatering system.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in [**Section 015000 "Temporary Facilities and Controls,"**][**Section 015723 "Temporary Storm Water Pollution Control"**][**Section 311000 "Site Clearing,"**] during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below groundwater level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control groundwater to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of [**24 inches (600 mm)**][**60 inches (1500 mm)**]<**Insert dimension**> below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of **36 inches (900 mm)** below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of groundwater and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well

risers to demonstrate that observation wells are functioning properly.

3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**][**monthly**]<**Insert time period**> during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19 00

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Task	Specification	Specification Description
31 23 19 00	31 20 00 00	Earth Moving
31 23 23 00	31 20 00 00	Earth Moving
31 23 23 23	31 20 00 00	Earth Moving
31 23 23 33	31 20 00 00	Earth Moving
31 24 00 00	31 20 00 00	Earth Moving

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SECTION 31 24 13 00 - LEVEE CLOSURE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing of labor and materials for providing levee closures.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. If there is deemed, by the Owner, to be considerable risk of flooding involved with removing drainage structures and gates in the existing Levee System, the Contractor shall perform the work of this contract as follows:
   1. Only one drainage structure/flap gate will be allowed to be disrupted at one time. All proposed work at each drainage structure shall be completed before proceeding to the next structure.
   2. The Contractor shall have all materials required for each structure installation secured on site, before beginning construction on that structure.
   3. The Contractor shall have all necessary materials on site to temporarily plug existing and/or proposed piping through the levee.
   4. Weather and river flow conditions shall be monitored at all times by the Contractor while each drainage structure is open to flow. The Contractor shall construct an adequate closure in a timely fashion to plug the drainage structure preventing flow through the levee.

END OF SECTION 31 24 13 00

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Task	Specification	Specification Description
31 24 13 00	31 20 00 00	Earth Moving
31 25 00 00	31 20 00 00	Earth Moving
31 25 14 00	31 20 00 00	Earth Moving
31 25 14 13	31 20 00 00	Earth Moving
31 25 14 16	31 20 00 00	Earth Moving
31 25 14 23	31 20 00 00	Earth Moving
31 25 14 23	32 14 00 00	Unit Paving
31 25 14 26	31 20 00 00	Earth Moving

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SECTION 31 31 16 00 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment.
2. Wood treatment.
3. Bait-station system.
4. Metal mesh barrier system.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood preservative treatment by pressure process.
2. Section 076200 "Sheet Metal Flashing and Trim" for custom-fabricated, metal termite shields.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
2. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of termite control product.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Termiticide brand name and manufacturer.
3. Quantity of undiluted termiticide used.
4. Dilutions, methods, volumes used, and rates of application.
5. Areas of application.

E. Bait-Station System Installation Report: After installation of bait-station system is completed, submit report for Owner's records and include the following:

1. Location of areas and sites conducive to termite feeding and activity.
2. Plan drawing showing number and locations of bait stations.
3. Dated report for each monitoring and inspection occurrence, indicating level of termite activity, procedure, and treatment applied before time of Substantial Completion.
4. Termiticide brand name and manufacturer.
5. Quantities of [**termiticide**][**and**][**nontoxic termite bait**] used.
6. Schedule of inspections for one year from date of Substantial Completion.

F. Research/Evaluation Reports: For metal mesh barrier system, from <**Insert applicable model code organization**>.

G. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located[**and who employs workers trained and approved by manufacturer to install manufacturer's products**][**and who is accredited by manufacturer**].

1.6 FIELD CONDITIONS

A. Soil Treatment:

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.7 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites[**, including Formosan termites (Coptotermes formosanus)**]<**Insert requirement**>. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: [**Three**][**Five**]<**Insert number**> years from date of Substantial Completion.

B. Wood Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor,

certifying that termite control work consisting of applied wood termiticide treatment will prevent infestation of subterranean termites[**, including Formosan termites (Coptotermes formosanus)**]<**Insert requirement**>. If subterranean termite damage is discovered during warranty period, repair or replace damage caused by termite infestation and treat replacement wood.

1. Warranty Period: [**12**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain termite control products from single source[**from single manufacturer**].

2.2 SOIL TREATMENT

A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bayer Environmental Science**]
    b. [**Ensystex, Inc**]
    c. [**Syngenta Crop Protection, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bayer Environmental Science**]
    b. [**Ensystex, Inc**]
    c. [**Syngenta Crop Protection, LLC**]
    d. <**Insert manufacturer's name**>

3. Service Life of Treatment: Soil treatment termiticide that is effective for not less than [**three**][**five**]<**Insert number**> years against infestation of subterranean termites.

2.3 WOOD TREATMENT

A. Borate: EPA-Registered borate termiticide acceptable to authorities having jurisdiction, in an aqueous solution for spray application and a gel solution for pressure injection, formulated to prevent termite infestation in wood.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ensystex, Inc**]
b. [**Nisus Corporation**]
c. [**NovaGuard Technologies, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ensystex, Inc**]
b. [**Nisus Corporation**]
c. [**NovaGuard Technologies, Inc**]
d. <**Insert manufacturer's name**>

2.4 BAIT-STATION SYSTEM

A. Bait-Station System: EPA-Registered system acceptable to authorities having jurisdiction. Provide bait stations based on the dimensions of building perimeter indicated on Drawings, according to product's EPA-Registered Label and manufacturer's written instructions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ensystex, Inc**]
b. [**The Dow Chemical Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ensystex, Inc**]
b. [**The Dow Chemical Company**]
c. <**Insert manufacturer's name**>

2.5 METAL MESH BARRIER SYSTEM

A. Stainless-Steel Mesh Barrier System: **0.025-by-0.018-inch (0.64-by-0.45-mm)** mesh of **0.08-inch- (2.0-mm-)** diameter, stainless-steel wire, Type 316.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Termimesh, LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Termimesh, LLC**]
b. <**Insert manufacturer's name**>

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for[**moisture content of soil per termiticide label,**] interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
3. Crawlspaces: Soil under and adjacent to foundations. Treat adjacent areas, including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
4. Masonry: Treat voids.
5. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 APPLYING WOOD TREATMENT

A. Wood Treatment: Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.

B. Application: Mix borate wood treatment solution to a uniform consistency. Apply treatment at the product's EPA-Registered Label volume and rate for the maximum borate concentration allowed for each specific use so that wood framing, sheathing, siding, and structural members subject to infestation receive treatment.[**Apply treatment to the height of 8 feet (244 mm) above grade**]<**Insert requirement**>.

1. Framing and Sheathing: Apply termiticide solution by spray to bare wood and with complete coverage.
2. Heavy Wood Members: For wood greater than **4 inches (100 mm)** thick, inject termiticide gel solution under pressure into holes of size and spacing required by manufacturer for treatment.
3. Exterior Uncoated Wood Trim and Siding: Apply termiticide solution to bare wood only when forecasted weather conditions indicate no precipitation or fog before application of seal coat. After 48 hours, verify that surface is sufficiently dry for seal coat and apply seal coat of [**paint**]<**Insert coating**> as specified in [**Section 099113 "Exterior Painting."**]<**Insert Section title**>.

3.5 INSTALLING BAIT-STATION SYSTEM

A. Bait-Station System: Install [**during construction to determine areas of termite activity**][**and**][**after construction, including landscaping, is completed**].

B. Place bait stations according to product's EPA-Registered Label and manufacturer's written instructions, in the following locations:

1. Conducive sites and locations indicated on Drawings.
2. In and around infested trees and stumps.
3. In mulch beds.
4. Where wood directly contacts soil.
5. Areas of high soil moisture.
6. Near irrigation sprinkler heads.
7. Each area where roof drainage system, including downspouts and scuppers, drains to soil.
8. Along driplines of roof overhangs without gutters.
9. Where condensate lines from mechanical equipment drip or drain to soil.
10. At plumbing penetrations through ground-supported slabs.
11. Other sites and locations as determined by licensed Installer.

C. Spacing: Place bait stations according to manufacturer's written instructions and at a frequency no less than the following:

1. One bait station per [**8 linear feet (2.4 linear meters)**][**20 linear feet (6.1 linear meters)**]<**Insert value**>.
2. One cluster of bait stations per **20 linear feet (6.1 linear meters)**, with no fewer than three bait stations per cluster.

3.6 INSTALLING METAL MESH BARRIER SYSTEM

A. Install metal mesh barrier system to provide a continuous barrier to entry of subterranean termites, according to manufacturer's written instructions.

1. Fit mesh tightly around pipes and other penetrations and terminate at slab and foundation perimeters.
2. Install mesh under the perimeter of concrete slab edges and joints after vapor retarder and reinforcing steel are in place.

3.7 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

3.8 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months' full maintenance by[**skilled employees of termite-control-treatment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] maintenance as required for proper performance according to the product's EPA-Registered Label and manufacturer's written instructions. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

B. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1. Include [**annual**]<**Insert time period**> inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions.

END OF SECTION 31 31 16 00

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Task	Specification	Specification Description
31 31 16 13	31 31 16 00	Termite Control

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SECTION 31 32 19 16 - POND AND RESERVOIR LINERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes geomembrane liners[**and floating covers**] for ponds and reservoirs fabricated from the following:

1. Linear low-density polyethylene (LLDPE).
2. High-density polyethylene (HDPE).
3. Polypropylene (PP).
4. Ethylene-propylene-diene monomer (EPDM).
5. Polyvinyl chloride (PVC).
6. Ethylene interpolymer alloy (EIA).
7. Chlorosulfonated polyethylene (CSPE).

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for perimeter concrete.
2. Section 221429 "Sump Pumps" for drainage of floating covers.
3. Section 312000 "Earth Moving" for excavating, compacting, and grading the subgrade; for excavating and backfilling the anchor trench; for protecting the earthwork; for removing ground water from subgrade to the extent required by liner manufacturer; for adding requirements for the earth cover; and for the filter fabric and other geotextiles.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and accessories for geomembrane liners[**and floating covers**].

B. Shop Drawings: Include panel layout, seams, penetrations, perimeter anchorage, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.

C. Samples: For each exposed product and for each color specified. Include one **12-inch (300-mm)** seam length for factory-bonded sheets and one **12-inch (300-mm)** seam length for field-bonded sheets.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of geomembrane liner[**and floating cover**].

C. Product Test Reports: For each geomembrane sheet, for tests performed by a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For geomembrane liner[**and floating cover**] to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: [**Fabricator of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace geomembrane liner[**and floating cover**] that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Leaks in geomembrane liner[**and floating cover**].
b. Defects in seams.
c. Cracks and holes in floating cover.

2. Warranty Period: [**One**][**Five**][**10**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain geomembrane liner[**and floating cover**], accessories, and required seaming materials, solvents, and adhesives from single source.

2.2 PERFORMANCE REQUIREMENTS

A. Provide geomembrane liners[**and floating covers**] that prevent the passage of water[**and gas**].

2.3 LLDPE SHEET MATERIALS

A. LLDPE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets with material properties complying with [**GRI Test Method GM17, non-reinforced,**][**GRI Test Method GM25, reinforced,**] for thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Agru America, Inc**]
    b. [**In Line Plastics, LC**]
    c. [**Integra Plastics, Inc**]
    d. [**Layfield Environmental Containment; Layfield Group Limited**]
    e. [**Poly-Flex, Inc**]
    f. [**Solmax International Inc.**]
    g. [**Viaflex**]
    h. [**Watersaver Company, Inc**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Agru America, Inc**]
    b. [**In Line Plastics, LC**]
    c. [**Integra Plastics, Inc**]
    d. [**Layfield Environmental Containment; Layfield Group Limited**]
    e. [**Poly-Flex, Inc**]
    f. [**Solmax International Inc.**]
    g. [**Viaflex**]
    h. [**Watersaver Company, Inc**]
    i. <**Insert manufacturer's name**>

3. Minimum Average Sheet Thickness: [**20 mils (0.50 mm)**][**30 mils (0.75 mm)**][**40 mils (1.00 mm)**][**50 mils (1.25 mm)**][**60 mils (1.50 mm)**][**80 mils (2.00 mm)**][**100 mils (2.50 mm)**][**120 mils (3.00 mm)**]<**Insert dimension**> per ASTM D5199.
4. Nominal Sheet Thickness: [**24 mils (0.61 mm)**][**36 mils (0.91 mm)**][**45 mils (1.10 mm)**]<**Insert dimension**> per ASTM D5199.
5. Sheet Texture: One side smooth; other side [**smooth**][**textured**].

2.4 HDPE SHEET MATERIALS

A. HDPE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets with material properties complying with GRI Test Method GM13 for thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Agru America, Inc**]
    b. [**In Line Plastics, LC**]
    c. [**Integra Plastics, Inc**]
    d. [**Layfield Environmental Containment; Layfield Group Limited**]
    e. [**Plastic Fusion Fabricators, Inc**]
    f. [**Poly-Flex, Inc**]
    g. [**Solmax International Inc.**]
    h. [**Viaflex**]
    i. [**Yunker Plastics, Inc.**]

j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. **[Agru America, Inc]**
   b. **[In Line Plastics, LC]**
   c. **[Integra Plastics, Inc]**
   d. **[Layfield Environmental Containment; Layfield Group Limited]**
   e. **[Plastic Fusion Fabricators, Inc]**
   f. **[Poly-Flex, Inc]**
   g. **[Solmax International Inc.]**
   h. **[Viaflex]**
   i. **[Yunker Plastics, Inc.]**
   j. **<Insert manufacturer's name>**

3. Minimum Average Sheet Thickness: **[30 mils (0.75 mm)][40 mils (1.00 mm)][50 mils (1.25 mm)][60 mils (1.50 mm)][80 mils (2.00 mm)][100 mils (2.50 mm)][120 mils (3.00 mm)]<Insert dimension>** per ASTM D5199.
4. Sheet Texture: One side smooth; other side **[smooth][textured]**.

2.5 PP SHEET MATERIALS

A. PP Sheet: Formulated from virgin PP, compounded for use in hydraulic structures, and formed into uniform, flexible **[non-reinforced][reinforced]** sheets with material properties complying with GRI Test Method GM18 for thickness indicated.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

   a. **[Carlisle Syntec Systems]**
   b. **[Cooley Group]**
   c. **[Elevate; Holcim Building Envelope]**
   d. **[Environmental Protection, Inc]**
   e. **[EVOQUA Water Technologies]**
   f. **[Integra Plastics, Inc]**
   g. **[Layfield Environmental Containment; Layfield Group Limited]**
   h. **[Viaflex]**
   i. **[Watersaver Company, Inc]**
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. **[Carlisle Syntec Systems]**
   b. **[Cooley Group]**
   c. **[Elevate; Holcim Building Envelope]**
   d. **[Environmental Protection, Inc]**
   e. **[EVOQUA Water Technologies]**
   f. **[Integra Plastics, Inc]**

g. [**Layfield Environmental Containment; Layfield Group Limited**]
h. [**Viaflex**]
i. [**Watersaver Company, Inc**]
j. <**Insert manufacturer's name**>

3. Minimum Average Sheet Thickness: [**30 mils (0.75 mm)**][**40 mils (1.00 mm)**][**60 mils (1.50 mm)**][**36 mils (0.91 mm)**][**45 mils (1.10 mm)**]<**Insert dimension**> per ASTM D5199.
4. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

a. Construction: [**9 x 9 - 1000 d**][**10 x 10 - 1000 d**]<**Insert value(s)**>.

5. Sheet Texture: One side smooth; other side [**smooth**][**textured**].

2.6 EPDM SHEET MATERIALS

A. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible [**non-reinforced**][**reinforced**] sheets with material properties complying with GRI Test Method GM21 for nominal thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Syntec Systems**]
b. [**Elevate; Holcim Building Envelope**]
c. [**Layfield Environmental Containment; Layfield Group Limited**]
d. [**Watersaver Company, Inc**]
e. [**Yunker Plastics, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Carlisle Syntec Systems**]
b. [**Elevate; Holcim Building Envelope**]
c. [**Layfield Environmental Containment; Layfield Group Limited**]
d. [**Watersaver Company, Inc**]
e. [**Yunker Plastics, Inc.**]
f. <**Insert manufacturer's name**>

3. Minimum Average Sheet Thickness: [**45 mils (1.10 mm)**][**60 mils (1.50 mm)**]<**Insert dimension**> per ASTM D5199.
4. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

a. Construction: [**9 x 9 - 1000 d**][**10 x 10 - 1000 d**]<**Insert value(s)**>.

2.7 PVC SHEET MATERIALS

A. PVC Sheet: Formulated from virgin PVC with plasticizers and other modifiers, compounded for use in hydraulic structures, and formed into uniform, flexible non-reinforced sheets with material properties complying with [**ASTM D7176**][**PGI 1104, "Specification for PVC Geomembranes,"**] for nominal thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Environmental Protection, Inc**]
    b. [**Solmax International Inc.**]
    c. [**Watersaver Company, Inc**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Environmental Protection, Inc**]
    b. [**Solmax International Inc.**]
    c. [**Watersaver Company, Inc**]
    d. <**Insert manufacturer's name**>

3. Nominal Thickness: [**10 mils (0.25 mm)**][**20 mils (0.51 mm)**][**30 mils (0.76 mm)**][**40 mils (1.02 mm)**][**50 mils (1.3 mm)**][**60 mils (1.5 mm)**].
4. Sheet Texture: One side smooth; other side [**smooth**][**matte**][**faille textured**].

2.8 EIA SHEET MATERIALS

A. EIA Sheet: Formulated from EIA for use in hydraulic structures and formed into uniform, flexible reinforced sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Burke Industries, Inc.**]
    b. [**Cooley Group**]
    c. [**EVOQUA Water Technologies**]
    d. [**Integra Plastics, Inc**]
    e. [**Seaman Corporation**]
    f. [**Watersaver Company, Inc**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Burke Industries, Inc.**]
    b. [**Cooley Group**]
    c. [**EVOQUA Water Technologies**]
    d. [**Integra Plastics, Inc**]
    e. [**Seaman Corporation**]
    f. [**Watersaver Company, Inc**]
    g. <**Insert manufacturer's name**>

3. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

a. Construction: [**6 x 6 - 1000 d**][**8 x 8 - 500 d**][**10 x 10 - 1000 d**][**10 x 11 - 2520 d x 2000 d**]<**Insert value(s)**>.

4. Nominal Thickness: [**36-mil- (0.91-mm-)**]<**Insert dimension**> thick sheet per ASTM D1593 or ASTM D751, Optical Method.
5. Tensile Strength: Not less than [**400 lbf (1.8 kN)**]<**Insert value**> minimum average per ASTM D751, Procedure A.
6. Tear Strength: Not less than [**35 lbf (0.16 kN)**]<**Insert value**> minimum average per ASTM D5884 or ASTM D751, Procedure B.
7. Puncture Resistance: Not less than [**150 lbf (0.67 kN)**]<**Insert value**> minimum average per ASTM D4833.
8. Hydrostatic Resistance: Not less than [**100-psi (690-kPa)**]<**Insert value**> minimum average resistance per ASTM D751, Procedure A.
9. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D1204.
10. Low-Temperature Flexibility: Pass, **1/8-inch (3-mm)** mandrel, four hours at **minus 30 deg F (minus 34 deg C)**, and per ASTM D2136.
11. UV-Light Resistance: Pass, 4000 hours at **176 deg F (80 deg C)**, per ASTM G155.
12. Ply Adhesion: Not less than [**7 lbf/in. (1.2 kN/m)**][**10 lbf/in. (1.75 kN/m)**]<**Insert value**> of seam width, or film tearing bond, according to ASTM D413, Machine Method.

2.9 CSPE SHEET MATERIALS

A. CSPE Sheet: Formulated from CSPE for use in hydraulic structures and formed into uniform, flexible reinforced sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burke Industries, Inc.**]
   b. [**EVOQUA Water Technologies**]
   c. [**Layfield Environmental Containment; Layfield Group Limited**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burke Industries, Inc.**]
   b. [**EVOQUA Water Technologies**]
   c. [**Layfield Environmental Containment; Layfield Group Limited**]
   d. <**Insert manufacturer's name**>

3. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

   a. Construction: [**6 x 6 - 1000 d**][**8 x 8 - 250 d**][**10 x 10 - 1000 d**]<**Insert value(s)**>.

4. Water Absorption: Not more than 2 percent at **70 deg F (21 deg C)** and not more than 30 percent at **158 deg F (70 deg C)** for 30 days each per ASTM D471, **30-mil- (0.76-mm-)** thick sheet.
5. Nominal Thickness: [**45-mil- (1.14-mm-)**]<**Insert dimension**> thick sheet per ASTM D5199 or ASTM D751, Optical Method.
6. Nominal Thickness over Scrim: [**11-mil- (0.28-mm-)**]<**Insert dimension**> thick sheet per ASTM D5199 or ASTM D751, Optical Method.

7. Breaking Strength: Not less than [200 lbf (0.89 kN)]<**Insert value**> minimum average per ASTM D751, Procedure A.
8. Tear Strength, Initial: Not less than [70 lbf (0.31 kN)]<**Insert value**> minimum average per ASTM D5884 or ASTM D751, Procedure B.
9. Tear Strength, after Aging: Not less than [35 lbf (0.16 kN)]<**Insert value**> minimum average per ASTM D5884 or ASTM D751, Procedure B.
10. Puncture Resistance: Not less than [200 lbf (0.89 kN)]<**Insert value**> minimum average per ASTM D4833.
11. Hydrostatic Resistance: Not less than [250-psi (1725-kPa)]<**Insert value**> minimum average resistance per ASTM D5514, Procedure A or ASTM D751, Method A, Procedure 1.
12. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D1204.
13. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 40 deg F (minus 40 deg C), and per ASTM D2136.
14. UV-Light Resistance: Pass, 4000 hours at 176 deg F (80 deg C), per ASTM G155.
15. Ply Adhesion: Not less than [7 lbf/in. (1.2 kN/m)][10 lbf/in. (1.75 kN/m)]<**Insert value**> of seam width, or film tearing bond, according to ASTM D413, Machine Method.

2.10 FLOATING COVER ACCESSORIES

A. Screened Scupper Hoses: Manufacturer's standard.

B. Flotation Blocks: Closed-cell PE foam blocks approximately 4 by 12 inches (102 by 300 mm), 2.2 lb/cu. ft. (35.2 kg/cu. m).

C. Access Hatch: Manufacturer's standard, in size indicated.

2.11 MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.

B. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.

C. Battens: Long-length strips of material indicated, size as indicated on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.

1. Batten Material:

   a. Liner manufacturer's standard system.
   b. Aluminum; with stainless steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
   c. Stainless steel; with stainless steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
   d. Plastic compatible with geomembrane liner, cast in place or fastened with stainless-steel anchors, designed to continuously seal geomembrane liner to batten.

D. Sand: ASTM C33/C33M; fine aggregate, natural or manufactured sand.

2.12 FABRICATION

A. Fabricate geomembrane liner[**and floating cover**] panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

B. Fabricate flotation blocks, wrap in geomembrane sheet, and attach to underside of floating cover according to manufacturer's written instructions.

C. Fabricate ballast tubes of sand-filled geomembrane sheet and attach to top surface of floating cover according to manufacturer's written instructions.

D. Install built-in accessories, hatches, access panels, vents, and walkways on geomembrane floating cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.

B. Examine anchor [**trench excavation**][**concrete perimeter**], where geomembrane liner[**and floating cover**] will be secured, for substrate conditions indicated above and for correct location and configuration.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.

B. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.

C. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

3.3 INSTALLATION

A. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.

B. Field Seams: Comply with geomembrane liner[**and floating cover**] manufacturer's written instructions. Form seams by lapping edges of panels **2 to 4 inches (50 to 102 mm)**, unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials.

Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.

1. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.
2. Thermal Bonding: Use thermal-welding technique recommended by geomembrane liner manufacturer. Apply pressure to smoothly bond surfaces together. Examine for and patch wrinkles and fishmouths.

C. Installation in Anchor Trench: Install geomembrane liner[**and floating cover**] in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.

D. Attachment to Concrete: Use manufacturer's standard system to suit Project conditions. Support adhesive and geomembrane on minimum **8-inch- (200-mm-)** wide concrete substrate unless otherwise indicated.

1. Install batten strips over geomembrane liner[**and floating cover**] as indicated on Drawings.
2. Install antichafing strips of geomembrane sheet between geomembrane liner and floating cover according to manufacturer's written instructions.
3. Install floating cover with perimeter fold.

E. Floating Cover Flotation Control: Connect drainage hoses in perimeter fold, sumps, or scuppers to pump or gravity drain system.

F. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner[**and floating cover**] and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.

C. Destructive Testing: Comply with GRI Test Method GM19, as applicable to geomembrane liner[**and floating cover**] and seam construction. Record locations of sample locations and failed seams. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches, and test sample locations.

D. Prepare test and inspection reports.

3.5 DISINFECTION

A. Disinfect the complete installation according to procedures in AWWA C652.

3.6 PROTECTION

A. Protect installed geomembrane liner[**and floating cover**] according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane liner and seams and reinspect repaired work.

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SECTION 31 50 00 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 312000 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

C. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Land surveyor.
2. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the [**jurisdiction**][**state**] in which Project is located.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using [**photographs**][**or**][**video recordings**], show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:

1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
2. Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
3. Compliance with requirements of authorities having jurisdiction.

4. Compliance with utility company requirements.
5. Compliance with railroad requirements.

2.2 MATERIALS

A. Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.

C. Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.

1. Corners: [**Site-fabricated mechanical interlock**][**Roll-formed corner shape with continuous interlock**].

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of [**size and strength required for application**][**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**>.

E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.

H. Tiebacks: Steel bars, ASTM A722/A722M.

I. Tiebacks: Steel strand, ASTM A416/A416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.3 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation.

1. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
2. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
3. Accurately align exposed faces of flanges to vary not more than [**2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment**]<**Insert tolerances**>.

B. Install wood lagging within flanges of soldier piles as excavation proceeds.

1. Trim excavation as required to install lagging.
2. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.4 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.

1. Limit vertical offset of adjacent sheet piling to **60 inches (1500 mm)**.
2. Accurately align exposed faces of sheet piling to vary not more than [**2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment**]<**Insert tolerances**>.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.5 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.8 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**][**daily**][**weekly**]<**Insert time period**> during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.9 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
2. Remove excavation support and protection systems to a minimum depth of [**48 (1200)**]<**Insert dimension**> **inches (mm)** below overlying construction, and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

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Task	Specification	Specification Description
31 52 00 00	31 50 00 00	Excavation Support and Protection
31 52 21 00	31 50 00 00	Excavation Support and Protection

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SECTION 31 62 13 00 - CONCRETE PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes [**hollow**][**solid**], precast, prestressed concrete piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles indicated from tip to cutoff, plus not less than **12 inches (305 mm)** of overlength for cutting piles at cutoff elevations.

B. Work of this Section is affected as follows:

1. Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest **12 inches (305 mm)**.

    a. Additional payment for splices required to extend pile lengths in excess of that indicated is calculated at unit prices stated in the Contract.

2. Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for furnishing, driving, cutting off, capping, and disposing of cutoffs.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles driven out of tolerance, defective piles, or piles damaged during handling or driving.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For concrete piles. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and lifting devices necessary for handling and driving piles.

1. Indicate pile dimensions, cross sections, locations, and sizes. Show details of pile splices and shoes.
2. Indicate types of reinforcement, including prestressing strand, and detail fabricating, bending, and placing.
3. Indicate layout and dimensions, and identify each pile. Indicate welded connections by AWS standard symbols. Detail cast-in hardware.

4. Indicate transportation, storage, and lifting points.
5. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittal: For concrete piles.

1. Indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**professional engineer**][**and**][**testing agency**].

B. Welding certificates.

C. Design Mixes: For each concrete mix.

D. Material Certificates: For [**steel reinforcements**][**prestressing strand**][**and**][**concrete admixtures**].

E. Material Test Reports: For concrete materials.

F. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

G. Static Pile Test Reports: Submit within three days of completing each test.

H. Pile-Driving Records: Submit within three days of driving each pile.

I. Certified Piles Survey: Submit within [**seven**]<**Insert number**> days of pile driving completion.

J. Field quality-control reports.

K. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Engineering Responsibility: Assumes engineering responsibility to comply with requirements in "Performance Requirements" Article by engaging a qualified professional engineer to prepare design calculations, Shop Drawings, and other structural data for piles.
2. PCI Plant Certification Program: Participates in PCI's Plant Certification Program and is designated a PCI-Certified Plant for [**B2**][**and**][**C2**] product group and category, or better.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing

indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

D. Design Practices: Comply with **ACI 318 (ACI 318M)** and the recommendations in PCI Committee Report: "Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling."

E. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for piles, comply with applicable requirements in PCI MNL-116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

F. Comply with requirements in ACI 301, "Specifications for Structural Concrete."

G. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.7 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**60 inches (1524 mm)**]<**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

   a. Procedure B, Maintained Test.
   b. Procedure C, Loading in Excess of Maintained Test.
   c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**]<**Insert number**> days to elapse after driving test piles before starting pile testing.
2. Number of Test Piles: [**One pile**][**As indicated**]<**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**]<**Insert load**>.

F. Approval Criteria: Allowable load is to be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]<**Insert value**>:

1. Net settlement, after deducting rebound, of not more than **0.01 inch/ton (0.25 mm/907 kg)** of test load.
2. Total settlement exceeds the pile elastic compression by **0.15 inch (4 mm)**, plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile[**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent cracking, distorting, warping, or other physical damage, and so markings are visible.

B. Lift and support piles only at designated lifting or supporting points as shown on Shop Drawings.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**][**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving.[**Comply with Section 013233 "Photographic Documentation."**]

PART 2 - PRODUCTS

2.1 CONCRETE PILES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality

Requirements," to design piles, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Piles withstand transportation, erection, and driving stresses and design loads within limits indicated and under conditions existing at Project site.

1. Design Loads: <**Insert loads**>.

2.3 MOLD MATERIALS

A. Molds: Provide molds of metal, plastic, wood, or another material that is nonreactive with concrete and that produces required finish surfaces.

2.4 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M.

C. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed.

E. Plain and Deformed Steel Wire: ASTM A1064/A1064M, [**as drawn**][**galvanized**].

F. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A coated, [**plain**][**deformed**].

2.5 PRESTRESSING TENDONS

A. Prestressing Strand: ASTM A416/A416M, **Grade 250 or 270 (Grade 1725 or 1860)**; uncoated, seven-wire, low-relaxation strand.

2.6 CONCRETE MATERIALS

A. General: Limit water-soluble chloride ions in concrete to the maximum percentage by mass of cementitious material permitted by **ACI 318 (ACI 318M)**, but not more than 0.06 percent.

B. Portland Cement: ASTM C150/C150M, [**Type I or Type III**][**Type II**], of same type, brand, and source.

1. Fly Ash: ASTM C618, Class C or F.
2. Silica Fume: ASTM C1240, amorphous silica.

C. Normal-Weight Aggregates: Except as modified by PCI MNL-116, ASTM C33/C33M, with coarse aggregates complying with [**Class 4S**][**Class 4M**][**Class 1N**]<**Insert class**>. Provide aggregates from

single source.

1. Nominal Maximum Size of Aggregate: [1 inch (25 mm)][3/4 inch (19 mm)].

D. Water: Potable, free of deleterious material that may affect color stability, setting, or strength of concrete, and complying with chemical limits of PCI MNL-116.

E. Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures.

1. Air-Entraining Admixture: ASTM C260/C260M.
2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
3. Retarding Admixture: ASTM C494/C494M, Type B.
4. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
5. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.
6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
7. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
8. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.7 PILE ACCESSORIES

A. Pile Shoes: 1-inch- (25-mm-) thick minimum, carbon-steel plate fabricated to match shape of pile tip.

B. Pile Splices: Manufactured from carbon-steel plates or castings and capable of developing strength of continuous pile at splice location.

2.8 CONCRETE MIXES

A. Prepare design mixes for each type of concrete required.

1. Limit use of fly ash and silica fume to not exceed, in total, [**25**]<**Insert number**> percent of portland cement by weight.

B. Design mixes may be prepared by a qualified independent testing agency or by qualified personnel at precast manufacturing plant at precast manufacturer's option.

C. Proportion mixes by either laboratory trial batch or field-test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): [8000 psi (55.2 MPa)][7000 psi (48.3 MPa)][6000 psi (41.4 MPa)][5000 psi (34.5 MPa)]<**Insert value**>.
2. Maximum Water-Cementitious Material Ratio: 0.40.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content of [**6.0 percent, plus or minus 1.5**][**2.5 to 4.5**] percent.

2.9 FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete placement and temperature changes and for pretensioning and detensioning operations. Maintain molds to provide completed piles of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116 and PCI MNL-135.

1. Unless molds are stripped before detensioning, design molds so stresses are not induced in piles due to deformation of concrete under prestress or movement during detensioning.
2. Chamfer edges and corners of square piles.

B. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

1. Accurately position, support, and secure reinforcement against displacement by molds, construction, or concrete placement. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
2. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

C. Prestress tendons for piles by either pretensioning or post-tensioning methods. Comply with PCI MNL-116.

D. Pile Shoes: Accurately position and secure pile shoes at pile tips so as to not affect pile alignment during driving. Weld pile shoes to longitudinal reinforcements.

E. Pile Splices: Accurately position and secure pile-splice segments requiring embedding in tips of piles.

F. Mix concrete according to PCI MNL-116 and requirements in this Section. After initial concrete batching, no additional water may be added.

G. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in piles. Comply with requirements in PCI MNL-116 for measuring, mixing, transporting, and placing concrete.

1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL-116.
2. Comply with ACI 306.1 procedures for cold-weather concrete placement.
3. Comply with ACI 305R recommendations for hot-weather concrete placement.

H. Identify pickup points of piles with permanent markings that correspond with markings indicated on Shop Drawings. Imprint casting date on each pile.

I. Cure concrete, according to requirements in PCI MNL-116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

J. Delay detensioning piles until concrete has attained at least [**70**]<**Insert number**> percent of its compressive strength as established by test cylinders cured under the same conditions as concrete.

1. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

K. Where ends of strands are not enclosed or covered, cut flush and cover with a high-strength mortar bonded to unit with an epoxy-resin bonding agent.

L. Fabricate precast, prestressed concrete piles straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL-116 and PCI MNL-135 product tolerances.

M. Finish: Fabricate concrete piles with normal plant-run finish produced in forms that impart a smooth finish to concrete. Small surface holes caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are tolerated. Major or unsightly imperfections, honeycombs, or structural defects are not permitted.

1. Finish unformed surfaces by trowel unless otherwise indicated. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

N. Pile-Length Markings: Mark each pile with horizontal lines at **12-inch (305-mm)** intervals; label the distance from pile tip at **60-inch (1524-mm)** intervals. Maintain markings on piles until driven.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate pile manufacturer's quality-control and testing methods.

1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency, and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

B. Testing: Test and inspect piles according to PCI MNL-116.

1. Strength of piles will be considered deficient if units fail to comply with requirements.

C. If there is evidence that strength of piles may be deficient or may not comply with PCI MNL-116 requirements, Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42/C42M.

1. A minimum of three representative cores are to be taken from piles of suspect strength, from locations directed by Architect.
2. Cores are to be tested, following immersion in water, in a wet condition in accordance with ACI 301 if piles are wet under service conditions.
3. Cores are to be tested in an air-dry condition in accordance with ACI 301 if piles are dry under service conditions.
4. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.
5. Test results are to be reported in writing on same day that tests are performed, with copies to Architect, Contractor, and pile manufacturer. Test reports are to include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete manufacturer.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of pile represented by core tests; design compressive strength; type of break; compressive strength at break, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

D. Patching: If core test results are satisfactory and piles comply with requirements, solidly fill core holes with patching mortar and finish to match adjacent pile surfaces.

E. Piles will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of **6 to 12 inches (152 to 305 mm)** above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

1. Use pile hammer capable of adjustment to deliver reduced impact to maintain tensile stress within 70 percent of yield strength of pile reinforcement.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated[**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Pile Splices: Splice piles during installation, and align pile segments concentrically.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: **4 inches (102 mm)** from location indicated after initial driving, and **6 inches (152 mm)** after pile driving is completed.
2. Plumb: Maintain **1 inch (25 mm)** in **48 inches (1219 mm)** from vertical, or a maximum of **4 inches (102 mm)**, measured when pile is aboveground in leads.
3. Batter Angle: Maximum **1 inch (25 mm)** in **48 inches (1219 mm)** from required angle, measured when pile is aboveground in leads.

F. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding **72 inches (1830 mm)**.
2. Fill holes left by withdrawn piles as directed by Architect.

G. Abandon and cut off rejected piles as directed by Architect. Leave rejected piles in place, and install new piles in locations as directed by Architect.

H. Cut off tops of driven piles square with pile axis and at elevations indicated.

I. Buildups: Construct buildups to elevations indicated of cast-in-place reinforced concrete with compressive strength not less than [**5000 psi (34.5 MPa)**]<**Insert value**> at 28 days.

J. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Type of pile and date of casting.
4. Pile location in pile group and designation of pile group.
5. Sequence of driving in pile group.
6. Pile dimensions.
7. Ground elevation.
8. Elevation of tips after driving.
9. Final tip and cutoff elevations of piles after driving pile group.
10. Records of redriving.
11. Elevation of splices.
12. Type, make, model, and rated energy of hammer.
13. Weight and stroke of hammer.
14. Type of pile-driving cap used.
15. Cushion material and thickness.
16. Actual stroke and blow rate of hammer.
17. Pile-driving start and finish times, and total driving time.
18. Time, pile-tip elevation, and reason for interruptions.
19. Number of blows for every **12 inches (305 mm)** of penetration, and number of blows per **1 inch (25 mm)** for the last **6 inches (152 mm)** of driving.
20. Pile deviations from location and plumb.
21. Preboring, jetting, or special procedures used.
22. Unusual occurrences during pile driving.

K. Certified Piles Survey: Engage a [**land surveyor**][**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring is to be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**][**3 percent of**]<**Insert number or percent of**> piles.
2. Low-strain integrity measurement is to be performed and reported for each pile.

D. Piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 31 62 13 00

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Task	Specification	Specification Description
31 62 13 23	31 62 13 00	Concrete Piles

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SECTION 31 62 16 00 - STEEL PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel H piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles indicated from tip to cutoff, plus not less than **12 inches (305 mm)** of overlength for cutting piles at cutoff elevations.

B. Work of this Section is affected as follows:

1. Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest **12 inches (305 mm)**.

a. Additional payment for splices required to extend pile lengths in excess of that indicated is calculated at unit prices stated in the Contract.

2. Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for furnishing, driving, cutting off, capping, and disposing of cutoffs.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles driven out of tolerance, defective piles, or piles damaged during handling or driving.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For steel H piles. Show fabrication and installation details for piles, including details of driving points, splices, and pile caps.

1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
2. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional

engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**professional engineer**][**and**][**testing agency**].

B. Welding certificates.

C. Mill Test Reports: For [**steel H piles**][**steel castings**][**and**][**steel plate**], signed by manufacturer.

D. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

E. Static Pile Test Reports: Submit within three days of completing each test.

F. Pile-Driving Records: Submit within three days of driving each pile.

G. Certified Piles Survey: Submit within [**seven**]<**Insert number**> days of pile driving completion.

H. Field quality-control reports.

I. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**60 inches (1524 mm)**]<**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

a. Procedure B, Maintained Test.

b. Procedure C, Loading in Excess of Maintained Test.
c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**]<**Insert number**> days to elapse after driving test piles before starting pile testing.
2. Number of Test Piles: [**One pile**][**As indicated**]<**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**]<**Insert load**>.

F. Approval Criteria: Allowable load shall be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]<**Insert value**>:

1. Net settlement, after deducting rebound, of not more than **0.01 inch/ton (0.25 mm/907 kg)** of test load.
2. Total settlement exceeds the pile elastic compression by **0.15 inch (4 mm)**, plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile[**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent buckling or physical damage.

1. Painted Piles: Protect finish and touch up paint damage before driving piles.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**][**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground

utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 STEEL H PILES

A. High-Strength, Low-Alloy, Columbium-Vanadium Structural Steel: ASTM A572/A572M, [**Grade 50 (Grade 345)**][**Grade 60 (Grade 415)**]<**Insert grade**>.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. <**Insert, in separate subparagraphs, manufacturer's name**>.

B. High-Strength, Low-Alloy, Nickel, Copper, Phosphorous Steel H Piles: ASTM A690/A690M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. <**Insert, in separate subparagraphs, manufacturer's name**>.

C. High-Strength, Low-Alloy, Structural Steel: ASTM A588/A588M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2.2 PILE ACCESSORIES

A. Driving Points: Manufacturer's standard one-piece driving point, fabricated from steel castings as follows to provide full bearing of web and flange of pile tip:

1. Carbon-Steel Castings: ASTM A27/A27M, [**Grade 65-35 (Grade 450-240), heat treated**][**or**][**Grade N1**].
2. High-Strength Steel Castings: ASTM A148/A148M, [**Grade 80-40 (Grade 550-275)**][**or**][**Grade 90-60 (Grade 620-415)**].

B. Splice Unit: Manufacturer's standard splice unit, fabricated from two connected steel plates, of same material as steel H pile or material of equal strength, shaped to encase web and part of each flange.

2.3 PAINT

A. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, [**black**][**red**][**manufacturer's standard color**].

2.4 FABRICATION

A. Fabricate and assemble piles in shop to greatest extent possible.

B. Pile-Length Markings: Mark each pile with horizontal lines at **12-inch (305-mm)** intervals; label the distance from pile tip at **60-inch (1524-mm)** intervals. Maintain markings on piles until driven.

C. Fabricate full-length piles to eliminate splicing during driving, with ends square.

D. Fabricate full-length piles by splicing lengths of steel H pile together. Accurately mill meeting ends of piles and bevel for welding. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.

1. Splice Units: Notch web of pile, fit splice unit into position, and weld according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
2. Continuously Welded Splices: Splice piles by continuously welding according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
3. Splice piles during fabrication[**or field installation**].

E. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

2.5 SHOP PAINTING

A. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:

1. Extend painting to a depth of **60 inches (1524 mm)** below [**finished grade**][**low-tide level**] to top of exposed pile.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, spatter, slag, and flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."

C. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than **8 mils (0.2 mm)**.

1. Apply second coat to provide a dry film thickness of not less than **8 mils (0.2 mm)**, resulting in a two-coat paint system thickness of not less than **16 mils (0.4 mm)**.
2. Apply second and third coats with each coat having a dry film thickness of not less than **8 mils (0.2 mm)**, resulting in a three-coat paint system thickness of not less than **24 mils (0.6 mm)**.
3. Mark pile lengths after shop painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of **6 to 12 inches (152 to 305 mm)** above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated[**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: **4 inches (102 mm)** from location indicated after initial driving, and **6 inches (152 mm)** after pile driving is completed.
2. Plumb: Maintain **1 inch (25 mm)** in **48 inches (1219 mm)** from vertical, or a maximum of **4 inches (102 mm)**, measured when pile is aboveground in leads.
3. Batter Angle: Maximum **1 inch (25 mm)** in **48 inches (1219 mm)** from required angle, measured when pile is aboveground in leads.

E. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding **72 inches (1830 mm)**.
2. Fill holes left by withdrawn piles as directed by Architect.

F. Abandon and cut off rejected piles as directed by Architect. Leave rejected piles in place, and install new piles in locations as directed by Architect.

G. Cut off tops of driven piles square with pile axis and at elevations indicated.

H. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile location in pile group and designation of pile group.
4. Sequence of driving in pile group.
5. Pile dimensions.
6. Ground elevation.
7. Elevation of tips after driving.
8. Final tip and cutoff elevations of piles after driving pile group.
9. Records of redriving.
10. Elevation of splices.
11. Type, make, model, and rated energy of hammer.
12. Weight and stroke of hammer.
13. Type of pile-driving cap used.
14. Cushion material and thickness.
15. Actual stroke and blow rate of hammer.
16. Pile-driving start and finish times, and total driving time.
17. Time, pile-tip elevation, and reason for interruptions.
18. Number of blows for every **12 inches (305 mm)** of penetration, and number of blows per **1 inch (25 mm)** for the last **6 inches (152 mm)** of driving.
19. Pile deviations from location and plumb.
20. Preboring, jetting, or special procedures used.
21. Unusual occurrences during pile driving.

I. Certified Piles Survey: Engage a [**land surveyor**][**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**][**3 percent of**]<**Insert number or percent of**> piles.
2. Weld Testing: In addition to visual inspection, welds shall be tested and inspected according to AWS D1.1/D1.1M and inspection procedures listed below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract

Documents.

a. Liquid Penetrant Inspection: ASTM E165.
b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
c. Radiographic Inspection: ASTM E94, minimum quality level "2-2T."
d. Ultrasonic Inspection: ASTM E164.

D. Steel H piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 TOUCHUP PAINTING

A. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.

1. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

3.6 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site, and legally dispose of them off Owner's property.

END OF SECTION 31 62 16 00

Task	Specification	Specification Description
31 62 16 16	31 62 16 00	Steel Piles
31 62 16 19	31 62 16 00	Steel Piles

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SECTION 31 62 19 00 - TIMBER PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes round timber piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles indicated from tip to cutoff, plus not less than **12 inches (305 mm)** of overlength for cutting piles at cutoff elevations.

B. Work of this Section is affected as follows:

1. Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest **12 inches (305 mm)**.

    a. Additional payment for splices required to extend pile lengths in excess of that indicated is calculated at unit prices stated in the Contract.

2. Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for furnishing, driving, cutting off, capping, and disposing of cutoffs.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles driven out of tolerance, defective piles, or piles damaged during handling or driving.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For timber piles. Show fabrication and installation details for piles, including details of driving shoes, tips or boots, and pile butt protection.

1. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**professional engineer**][**and**][**testing agency**].

B. Round timber pile treatment data as follows, including chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material:

1. For each type of preservative-treated timber product, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
2. For waterborne-treated products, include statement that moisture content of treated materials was reduced to levels indicated before shipment to Project site.

C. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

D. Static Pile Test Reports: Submit within three days of completing each test.

E. Pile-Driving Records: Submit within three days of driving each pile.

F. Certified Piles Survey: Submit within [**seven**]<**Insert number**> days of pile driving completion.

G. Field quality-control reports.

H. Material Certificates: For preservative-treated piles. Indicate type of preservative used and net amount of preservative retained.

I. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

1.7 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**60 inches (1524 mm)**]<**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][.]

a. Procedure B, Maintained Test.
b. Procedure C, Loading in Excess of Maintained Test.
c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**]<**Insert number**> days to elapse after driving test piles before starting pile testing.
2. Number of Test Piles: [**One pile**][**As indicated**]<**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**]<**Insert load**>.

F. Approval Criteria: Allowable load shall be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]<**Insert value**>:

1. Net settlement, after deducting rebound, of not more than **0.01 inch/ton (0.25 mm/907 kg)** of test load.
2. Total settlement exceeds the pile elastic compression by **0.15 inch (4 mm)**, plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile[**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent breaks, cuts, abrasions, or other physical damage and as required by AWPA M4.

1. Do not drill holes or drive spikes or nails into pile below cutoff elevation.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**][**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 TIMBER PILES

A. Round Timber Piles: ASTM D25, unused, clean peeled, one piece from butt to tip; of the following species and size basis:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert manufacturer's name**>

2. Species: [**Coastal Douglas fir**][**Southern yellow pine**]<**Insert species**>.
3. Size Basis: [**Butt circumference**][**Class A**][**Class B**][**Tip circumference**][**8-inch (203-mm) tip and natural taper**].

B. Pressure-treat round timber piles according to AWPA U1 as follows:

1. Service Condition: [**UC4C Ground Contact, Extreme Duty**][**UC5A Marine Use Northern Waters**][**UC5B Marine Use Central Waters**][**UC5C Marine Use Southern Waters**]
2. Treatment: [**Waterborne preservative**][**Creosote or creosote solution**][**Oil-borne preservative**][**Waterborne preservative, creosote or creosote solution, or oil-borne preservative**][**Waterborne preservative, severe marine borer hazard**][**Dual treatment consisting of waterborne preservative, followed by creosote or creosote solution**]<**Insert treatment**>.

2.2 PILE ACCESSORIES

A. Driving Shoes: Fabricate from ASTM A1011/A1011M, hot-rolled carbon-steel strip to suit pile-tip diameter, of the following type and thickness, and secure to pile tip so as to not affect pile alignment during driving:

1. Type: [**Flat boot**][**Arrow point**].
2. Thickness: [**3/16 inch (4.8 mm)**][**1/4 inch (6 mm)**].

2.3 FABRICATION

A. Pile Tips: Cut and shape pile tips to accept driving shoes. Fit and fasten driving shoes to pile tips according to manufacturer's written instructions.

B. Pile Butt: Trim pile butt and cut perpendicular to longitudinal axis of pile. Chamfer and shape butt to fit tightly to driving cap of hammer.

C. Field-Applied Wood Preservative: Treat field cuts, holes, and other penetrations according to AWPA M4.

1. Coal-tar roofing cement for treating drilled holes or sealing cutoffs shall be free of asbestos.

D. Pile Splices: Splices are not permitted.

E. Pile-Length Markings: Mark each pile with horizontal lines at **12-inch (305-mm)** intervals; label the distance from pile tip at **60-inch (1524-mm)** intervals. Maintain markings on piles until driven.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of **6 to 12 inches (152 to 305 mm)** above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated[**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Spudding: Drive spud piles through overlying highly resistant strata or obstructions and withdraw for reuse.

C. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

D. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: **4 inches (102 mm)** from location indicated after initial driving, and **6 inches (152 mm)** after pile driving is completed.
2. Plumb: Maintain **1 inch (25 mm)** in **48 inches (1219 mm)** from vertical, or a maximum of **4 inches (102 mm)**, measured when pile is aboveground in leads.

3. Batter Angle: Maximum 1 inch (25 mm) in 48 inches (1219 mm) from required angle, measured when pile is aboveground in leads.

F. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 72 inches (1830 mm).
2. Fill holes left by withdrawn piles as directed by Architect.

G. Abandon and cut off rejected piles as directed by Architect. Leave rejected piles in place and install new piles in locations as directed by Architect.

H. Cut off butts of driven piles square with pile axis and at elevations indicated.

1. Cover cut-off piling surfaces with [**caps overlapping pile end by minimum 2 inches (51 mm)**][**minimum three coats of preservative treatment**] according to AWPA M4.

I. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile species.
4. Pile location in pile group and designation of pile group.
5. Sequence of driving in pile group.
6. Pile dimensions.
7. Ground elevation.
8. Elevation of tips after driving.
9. Final tip and cutoff elevations of piles after driving pile group.
10. Records of redriving.
11. Elevation of splices.
12. Type, make, model, and rated energy of hammer.
13. Weight and stroke of hammer.
14. Type of pile-driving cap used.
15. Cushion material and thickness.
16. Actual stroke and blow rate of hammer.
17. Pile-driving start and finish times, and total driving time.
18. Time, pile-tip elevation, and reason for interruptions.
19. Number of blows for every 12 inches (305 mm) of penetration, and number of blows per 1 inch (25 mm) for the last 6 inches (152 mm) of driving.
20. Pile deviations from location and plumb.
21. Preboring, jetting, or special procedures used.
22. Unusual occurrences during pile driving.

J. Certified Piles Survey: Engage a [**land surveyor**][**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**][**3 percent of**]<**Insert number or percent of**> piles.

3.5 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 31 62 19 00

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SECTION 31 62 23 00 - COMPOSITE PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete-filled [**steel-shell**][**steel pipe**] piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles indicated from tip to cutoff, plus not less than **12 inches (305 mm)** of overlength for cutting piles at cutoff elevations.

B. Work of this Section is affected as follows:

1. Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest **12 inches (305 mm)**.

    a. Additional payment for splices required to extend pile lengths in excess of that indicated is calculated at unit prices stated in the Contract.

2. Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for furnishing, driving, cutting off, capping, and disposing of cutoffs.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles driven out of tolerance, defective piles, or piles damaged during handling or driving.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For composite piles. Show fabrication and installation details for piles, including splices and tip details.

1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
2. Indicate locations, sizes, type, and arrangement of reinforcement.
3. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**professional engineer**][**and**][**testing agency**].

B. Welding certificates.

C. Design Mixes: For each concrete mix. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Material Certificates: For [**steel-shell piles and accessories**][**steel pipe piles and accessories**][**steel reinforcement**][**and**][**concrete admixtures**].

E. Material Test Reports: For concrete materials.

F. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

1. Include mandrel type and details.

G. Static Pile Test Reports: Submit within three days of completing each test.

H. Pile-Driving Records: Submit within three days of driving each pile.

I. Certified Piles Survey: Submit within [**seven**]<**Insert number**> days of pile-driving completion.

J. Field quality-control reports.

K. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

C. Comply with requirements in ACI 301, "Specifications for Structural Concrete."

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.7 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load

of piles.

1. Furnish test piles [60 inches (1524 mm)]<**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

   a. Procedure B, Maintained Test.
   b. Procedure C, Loading in Excess of Maintained Test.
   c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**]<**Insert number**> days to elapse after driving test piles before starting pile testing.
2. Number of Test Piles: [**One pile**][**As indicated**]<**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**]<**Insert load**>.

F. Approval Criteria: Allowable load is to be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]<**Insert value**>:

1. Net settlement, after deducting rebound, of not more than **0.01 inch/ton (0.25 mm/907 kg)** of test load.
2. Total settlement exceeds the pile elastic compression by **0.15 inch (4 mm)**, plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile[**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent physical damage.

1. Painted Piles: Protect finish and touch up damage before driving piles.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**][**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 STEEL-SHELL PILES

A. Fluted Pile Shells: Manufacturer's standard, vertically fluted, pile shells; cold formed from steel sheet; **50,000-psi (345-MPa)** minimum yield strength after forming. Fabricate watertight, uniformly tapered sections with forged-steel conical nose welded to tip.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Monotube Pile Corporation**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Monotube Pile Corporation**]
   b. <**Insert manufacturer's name**>

3. Constant Diameter Extensions: Fabricate with splice overlap capable of telescoping into tapered section.
4. Taper: [**0.14 inch in 12 inches (1:86)**][**0.25 inch in 12 inches (1:48)**][**0.40 inch in 12 inches (1:30)**].
5. Thickness: [**0.150 inch (3.80 mm)**][**0.179 inch (4.55 mm)**][**0.209 inch (5.31 mm)**][**0.239 inch (6.07 mm)**].

B. Helically Corrugated Pile Shells: Manufacturer's standard, helically corrugated, uniform-diameter, steel sheet shell piles; of enough strength and thickness to remain watertight and resist distortion and buckling due to soil pressure, internal mandrel operation, or redriving. Fabricate in one-piece lengths with minimum **3/16-inch- (4.76-mm-)** thick steel-plate boot continuously welded to tip and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Contech Engineered Solutions LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Contech Engineered Solutions LLC**]
b. <**Insert manufacturer's name**>

3. Nominal Diameter: [**8-5/8 inches (219 mm)**][**10-5/8 inches (270 mm)**][**11-1/8 inches (283 mm)**][**12-1/4 inches (311 mm)**][**14 inches (350 mm)**][**16-1/8 inches (410 mm)**].
4. Thickness: [**0.048 inch (1.21 mm)**, **minimum**][**0.060 inch (1.52 mm)**, **minimum**][**0.075 inch (1.90 mm)**, **minimum**][**0.105 inch (2.66 mm)**]<**Insert dimension**>.

2.2 STEEL PIPE PILES

A. Steel Pipe: ASTM A252, [**Grade 2**][**Grade 3**]; seamless or welded.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M.

C. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**]; deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**]; deformed.

E. Plain and Deformed Steel Wire: ASTM A1064/A1064M, [**as drawn**][**galvanized**].

F. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A coated, [**plain**][**deformed**].

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II.

1. Fly Ash: ASTM C618, Class C or F.
2. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

B. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, portland-pozzolan**][**Type I (PM), pozzolan-modified portland**][**Type I (SM), slag-modified portland**] cement.

C. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 4S**][**Class 4M**][**Class 1N**]<**Insert class**>, uniformly graded, **3/4-inch (19-mm)** maximum aggregate size. Provide aggregates from a single source.

D. Water: Potable, complying with ASTM C94/C94M requirements.

E. Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain no more than 0.1 percent chloride ions by mass of cementitious material.

1. Air-Entraining Admixture: ASTM C260/C260M.
2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
3. Retarding Admixture: ASTM C494/C494M, Type B.
4. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.5 PILE ACCESSORIES

A. Driving Points: Manufacturer's standard 60-degree conical driving point, with integral reinforcing ribs, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

B. Inside Cutting Shoes: Manufacturer's standard, inside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

C. Outside Cutting Shoes: Manufacturer's standard, outside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

1. Carbon-Steel Castings: ASTM A27/A27M, [**Grade 65-35 (Grade 450-240), heat treated**][**or**][**Grade N1**].
2. High-Strength Steel Castings: ASTM A148/A148M, [**Grade 80-40 (Grade 550-275)**][**or**][**Grade 90-60 (Grade 620-415)**].

D. Splice Coupling: Manufacturer's standard splice coupling, rolled from ASTM A36/A36M, carbon-steel bar or cast from heat-treated carbon steel, ASTM A27/A27M, **Grade 65-35 (Grade 450-240)**, with interior stop and internally tapered for friction fit driving.

2.6 PAINT

A. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, [**black**][**red**][**manufacturer's standard color**].

2.7 CONCRETE MIXES

A. Prepare concrete design mixes according to ACI 301, determined by either laboratory trial batch or field test data basis.

1. Use a qualified testing agency for preparing and reporting proposed mix designs determined by laboratory trial batch.

B. Proportion mixes according to ACI 301 to provide normal-weight concrete suitable for piles with the

following properties:

1. Compressive Strength (28 Days): [**5000 psi (34.5 MPa)**][**4000 psi (27.6 MPa)**][**3000 psi (20.7 MPa)**]<**Insert value**>.
2. Maximum Water-Cementitious Material Ratio at Point of Placement: [**0.45**][**0.50**]<**Insert ratio**>.
3. Slump Limit: [**5 inches (127 mm)**][**8 inches (203 mm)**]<**Insert dimension**>, plus or minus **1 inch (25 mm)**.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content of [**6.0 percent, plus or minus 1.5**][**2.5 to 4.5**] percent.

D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

E. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**][**0.30**] percent by weight of cement.

F. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval from Architect of proposed changes to concrete-mix proportions.

2.8 FABRICATION

A. Fabricate and assemble piles in shop to greatest extent possible.

B. Fabricate full-length piles to eliminate splicing during driving.

C. Fabricate full-length piles by splicing pile lengths together. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.

1. Splice Coupling: Fit splice coupling into position and weld to adjoining steel pipe pile sections according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
2. Welded Splices, Steel Pipe Piles: Accurately mill meeting ends of steel pipe piles, and bevel for welding. Continuously weld pile according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
3. Welded Splices, Steel-Shell Piles: Continuously weld steel-shell pile according to manufacturer's written instructions and AWS D1.1/D1.1M[**and AWS D1.3/D1.3M**] for procedures, appearance and quality of welds, and methods used in correcting welding work.
4. Splice piles during fabrication or field installation.

D. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

E. Fit and weld cutting shoes to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

F. Pile-Length Markings: Mark each pile with horizontal lines at **12-inch (305-mm)** intervals; label the distance from pile tip at **60-inch (1524-mm)** intervals. Maintain markings on piles until driven.

2.9 SHOP PAINTING

A. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:

1. Extend painting to a depth of **60 inches (1524 mm)** below [**finished grade**][**low-tide level**] to top of exposed pile.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, and remove spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."

C. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than **8 mils (0.2 mm)**.

1. Apply second coat to provide a dry film thickness of not less than **8 mils (0.2 mm)**, resulting in a two-coat paint system thickness of not less than **16 mils (0.4 mm)**.
2. Apply second and third coats with each coat having a dry film thickness of not less than **8 mils (0.2 mm)**, resulting in a three-coat paint system thickness of not less than **24 mils (0.6 mm)**.
3. Mark pile lengths after shop painting.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with ASTM C94/C94M.

1. Do not add water to concrete mix after mixing.
2. Maintain concrete temperature to not exceed **90 deg F (32 deg C)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of **6 to 12 inches (152 to 305 mm)** above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

D. Mandrel: Expandable mandrel, capable of distributing driving energy throughout length of steel-shell pile.

3.3 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcement cages symmetrically about axis of pile [**shell**][**pipe**] in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover on reinforcement.

E. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

A. Do not place concrete until other piles within a radius of [**20 feet (6 m)**]<**Insert value**> have been driven and approved.

B. Inspection: Before placing concrete, allow testing and inspecting agency to visually inspect and verify that each pile [**shell**][**pipe**] is clean, watertight, plumb, and free of distortion or other defects.

C. Place concrete in a continuous operation and without segregation immediately after cleaning out pile [**shell**][**pipe**].

D. Place concrete by means of bottom discharge bucket, flexible drop chute, or steep-sided funnel hopper or tremie or pump concrete into place.

E. Place concrete in a dry pile [**shell**][**pipe**] unless placement underwater is approved by Architect.

1. Place concrete underwater by tremie method or pumping. Control placement operations to ensure tremie is embedded no less than **60 inches (1524 mm)** into concrete, and flow of tremied concrete is continuous from bottom to top of pile [**shell**][**pipe**].
2. Other methods of depositing concrete may be used if approved by Architect.

F. Consolidate final **10 feet (3 m)** of concrete during placement to ensure that concrete is thoroughly worked around steel reinforcement and into corners.

G. Screed concrete level at cutoff elevation and apply a scoured, rough finish.

3.5 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated[**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Pile Splices: Splice piles during installation and align pile segments concentrically.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: **4 inches (102 mm)** from location indicated after initial driving, and **6 inches (152 mm)** after pile driving is completed.
2. Plumb: Maintain **1 inch (25 mm)** in **48 inches (1219 mm)** from vertical, or a maximum of **4 inches (102 mm)**, measured when pile is aboveground in leads.
3. Batter Angle: Maximum **1 inch (25 mm)** in **48 inches (1219 mm)** from required angle, measured when pile is aboveground in leads.

F. Excavation: Clean out steel pipe pile by removing soil and debris from inside pile before placing steel reinforcement or concrete.

G. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding **72 inches (1830 mm)**.
2. Fill holes left by withdrawn piles as directed by Architect.

H. Abandon and cut off rejected piles as directed by Architect. Leave rejected piles in place, and install new piles in locations as directed by Architect.

I. Cut off tops of driven piles square with pile axis and at elevations indicated.

J. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile location in pile group and designation of pile group.
4. Sequence of driving in pile group.
5. Pile dimensions.
6. Ground elevation.
7. Elevation of tips after driving.
8. Final tip and cutoff elevations of piles after driving pile group.
9. Records of redriving.
10. Elevation of splices.
11. Type, make, model, and rated energy of hammer.
12. Weight and stroke of hammer.
13. Type of pile-driving cap used.
14. Cushion material and thickness.
15. Actual stroke and blow rate of hammer.
16. Pile-driving start and finish times, and total driving time.
17. Time, pile-tip elevation, and reason for interruptions.
18. Number of blows for every **12 inches (305 mm)** of penetration, and number of blows per **1 inch (25 mm)** for the last **6 inches (152 mm)** of driving.
19. Pile deviations from location and plumb.
20. Preboring, jetting, or special procedures used.
21. Unusual occurrences during pile driving.

K. Certified Piles Survey: Engage a [**land surveyor**][**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring is to be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**][**3 percent of**]<**Insert number or percent of**> piles.
2. Low-strain integrity measurement is to be performed and reported for each pile.
3. Weld Testing: In addition to visual inspection, welds are to be tested and inspected according to AWS D1.1/D1.1M and the inspection procedures listed in subparagraphs below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

    a. Liquid Penetrant Inspection: ASTM E165.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Radiographic Inspection: ASTM E94; minimum quality level "2-2T."
    d. Ultrasonic Inspection: ASTM E164.

4. Concrete: Sampling and testing of concrete for quality control is to include the following:

    a. Sampling Fresh Concrete: ASTM C172/C172M, except modified for slump to comply with ASTM C94/C94M.

        1) Slump: ASTM C143/C143M; one test at point of placement for each compressive-strength test, but no fewer than one test for each concrete load.
        2) Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is **40 deg F (5 deg C)** and below or when **80 deg F (27 deg C)** and above, and one test for each set of compressive-strength specimens.
        3) Compression Test Specimens: ASTM C31/C31M; one set of [**four**]<**Insert number**> standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
        4) Compressive-Strength Tests: ASTM C39/C39M; one set for each truck load. One specimen is to be tested at seven days, two specimens are to be tested at 28 days, and one specimen is to be retained in reserve for later testing if required.

    b. When frequency of testing provides fewer than five strength tests for a given class of concrete, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
    c. When strength of field-cured cylinders is less than 85 percent of companion laboratory-

cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.

d. Strength level of concrete is considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than **500 psi (3.45 MPa)**.

e. Test results are to be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests are to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in piles, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

f. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but is not to be used as sole basis for acceptance or rejection.

g. Additional Tests: Testing and inspecting agency is to make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.

D. Concrete-filled steel piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 TOUCHUP PAINTING

A. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.

1. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

3.8 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site, and legally dispose of them off Owner's property.

END OF SECTION 31 62 23 00

Task	Specification	Specification Description
31 62 23 13	31 62 23 00	Composite Piles

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Task	Specification	Specification Description
32 01 11 53	07 18 00 00	Traffic Coatings
32 01 11 53	32 12 16 00	Asphalt Paving
32 01 11 53	32 13 13 00	Concrete Paving
32 01 13 61	32 12 16 00	Asphalt Paving
32 01 16 74	32 12 16 00	Asphalt Paving
32 01 17 61	32 12 16 00	Asphalt Paving
32 01 17 63	32 12 16 00	Asphalt Paving
32 12 13 13	32 12 16 00	Asphalt Paving
32 12 13 19	32 12 16 00	Asphalt Paving

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SECTION 32 12 16 00 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt overlay.
3. Cold milling of existing asphalt pavement.
4. Hot-mix asphalt patching.
5. Asphalt curbs.
6. Asphalt traffic-calming devices.
7. Asphalt surface treatments.

B. Related Requirements:

1. [**Section 024116 "Structure Demolition"**][**and**][**Section 024119 "Selective Demolition"**] for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
4. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.
5. Section 321400 "Unit Paving" for bituminous setting bed for pavers and for stone and precast concrete curbs.

1.2 UNIT PRICES

A. Work of this Section is affected by <**Insert name of unit price**>.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Herbicide.
2. Paving geotextile.
3. Joint sealant.

B. Hot-Mix Asphalt Designs:

1. Certification, by authorities having jurisdiction, of approval of each hot-mix asphalt design proposed for the Work.
2. For each hot-mix asphalt design proposed for the Work.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

D. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:

1. Paving Geotextile: **12 by 12 inches (300 by 300 mm)** minimum.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**paving-mix manufacturer**][**and**][**testing agency**].

B. Material Certificates:[**Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.**]

1. Aggregates.
2. Asphalt binder.
3. Asphalt cement.
4. Cutback prime coat.
5. Emulsified asphalt prime coat.
6. Tack coat.
7. Fog seal.
8. Undersealing asphalt.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: [**A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located**]<**Insert requirement**>.

B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of <**Insert applicable standards**> of <**Insert name of state or local DOT**> for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of **60 deg F (15.6 deg C)**.
2. Tack Coat: Minimum surface temperature of **60 deg F (15.6 deg C)**.
3. Slurry Coat: Comply with weather limitations in ASTM D3910.
4. Asphalt Base Course[**and Binder Course**]: Minimum surface temperature of **40 deg F (4.4 deg C)** and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of **60 deg F (15.6 deg C)** at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D692/D692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: [**ASTM D1073**][**or**][**AASHTO M 29**], sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: [**ASTM D242/D242M**][**or**][**AASHTO M 17**], rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: [**ASTM D6373**][**or**][**AASHTO M 320**] binder designation [**PG 58-28**][**PG 64-22**][**PG 70-22**]<**Insert performance grade**>.

B. Asphalt Cement: [**ASTM D3381/D3381M for viscosity-graded material**][**ASTM D946/D946M for penetration-graded material**].

C. Cutback Prime Coat: ASTM D2027/D2027M, medium-curing cutback asphalt, [**MC-30 or MC-70**][**MC-250**].

D. Emulsified Asphalt Prime Coat: [**ASTM D977**][**or**][**AASHTO M 140**] emulsified asphalt, or [**ASTM D2397/D2397M**][**or**][**AASHTO M 208**] cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Tack Coat: [**ASTM D977**][**or**][**AASHTO M 140**] emulsified asphalt, or [**ASTM D2397/D2397M**][**or**][**AASHTO M 208**] cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Fog Seal: [**ASTM D977**][**or**][**AASHTO M 140**] emulsified asphalt, or [**ASTM**

D2397/D2397M][**or**][**AASHTO M 208**] cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

G. Water: Potable.

H. Undersealing Asphalt: ASTM D3141/D3141M; pumping consistency.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled [**tires**][**asphalt shingles**][**or**][**glass**] from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Sand: [**ASTM D1073**][**or**][**AASHTO M 29**], Grade No. 2 or No. 3.

D. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

E. Joint Sealant: ASTM D6690, [**Type I**][**Type II or III**][**Type IV**], hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

A. Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**10**][**20**][**40**]<**Insert value**> percent or more than [**15**][**25**][**50**]<**Insert value**> percent by weight.

1. Surface Course Limit: Recycled content no more than [**10**]<**Insert number**> percent by weight.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes [**approved by authorities having jurisdiction**][**; designed in accordance with procedures in AI MS-2, "Asphalt Mix Design Methods";**] and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: <**Insert mix designation**>.
3. Binder Course: <**Insert mix designation**>.
4. Surface Course: <**Insert mix designation**>.

C. Emulsified-Asphalt Slurry: ASTM D3910, [**Type 1**][**Type 2**][**Type 3**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction[**, repeating proof-rolling in direction perpendicular to first direction**]. Limit vehicle speed to **3 mph (5 km/h)**.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

3.3 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**>.
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, driveway aprons, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than **1 inch (25 mm)** after milling, before wearing course is laid.
7. Handle milled asphalt material in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."
8. Keep milled pavement surface free of loose material and dust.
9. Do not allow milled materials to accumulate on-site.

3.4 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending **12 inches (300 mm)** into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Undersealing: Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of **0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m)**.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Single-Course Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Two-Course Patch Material: Partially fill excavated pavements with hot-mix asphalt base course mix and, while still hot, compact. Cover asphalt base course with compacted layer of hot-mix asphalt surface course, finished flush with adjacent surfaces.

3.5 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than **1 inch (25 mm)** in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding **3 inches (75 mm)** thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of [**1/4 inch (6 mm)**]<**Insert dimension**>.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than **1/4 inch (6 mm)** wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than **1/4 inch (6 mm)** wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of **0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m)**. Apply enough material to penetrate and seal, but

not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of **0.10 to 0.30 gal./sq. yd. per inch depth (0.5 to 1.40 L/sq. m per 25 mm depth)**. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of **0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m)**.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.7 INSTALLATION OF PAVING GEOTEXTILE

A. Apply [**tack coat**][**asphalt binder**][**asphalt cement**] uniformly to existing pavement surfaces at a rate of **0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m)**.

B. Place paving geotextile promptly in accordance with manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints **4 inches (100 mm)** and transverse joints **6 inches (150 mm)**.

C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

3.8 HOT-MIX ASPHALT PLACEMENT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course[**and binder course**] in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of **250 deg F (121 deg C)**.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than **10 feet (3 m)** wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap

previous strips. Overlap mix placement about **1 to 1-1/2 inches (25 to 38 mm)** from strip to strip to ensure proper compaction of mix along longitudinal joints.

2. Complete a section of asphalt base course[**and binder course**] before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.9 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of **6 inches (150 mm)**.
3. Offset transverse joints, in successive courses, a minimum of **24 inches (600 mm)**.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints [**using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."**][**as indicated on Drawings.**]<**Insert joint requirement.**>
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.10 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to **185 deg F (85 deg C)**.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density, Marshall Test Method: 96 percent of reference laboratory density in accordance with [**ASTM D6927**][**or**][**AASHTO T 245**], but not less than 94 percent or greater than 100 percent.
2. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.11 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread hot-mix asphalt at a minimum temperature of **250 deg F (121 deg C)**.

1. Hot-Mix Asphalt: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 ASPHALT TRAFFIC-CALMING DEVICES

A. Construct hot-mix asphalt speed [**bumps**][**humps**][**cushions**][**and**][**tables**] over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread hot-mix asphalt at a minimum temperature of **250 deg F (121 deg C)**.

1. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of **0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m)**.
2. Hot-Mix Asphalt: Same as pavement surface-course mix.
3. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of **1 inch (25 mm)** from top of pavement to a clean, rough profile.

B. Place and compact hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.13 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:

1. Base Course[**and Binder Course**]: Plus or minus **1/2 inch (13 mm)**.
2. Surface Course: Plus **1/4 inch (6 mm)**, no minus.

B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a **10-foot (3-m)** straightedge applied transversely or longitudinally to paved areas:

1. Base Course[**and Binder Course**]: [**1/4 inch (6 mm)**]<**Insert dimension**>.
2. Surface Course: [**1/8 inch (3 mm)**]<**Insert dimension**>.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is **1/4 inch (6 mm)**.

C. Asphalt Traffic-Calming Devices: Compact and form asphalt to the shapes indicated and within a tolerance of plus or minus **1/8 inch (3 mm)** of height indicated above pavement surface.

3.14 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of **0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m)** to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness in accordance with ASTM D3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with [**ASTM D979/D979M**][**or**][**AASHTO T 168**].

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.

a. One core sample will be taken for every **1000 sq. yd. (836 sq. m)** or less of installed pavement, with no fewer than three cores taken.
b. Field density of in-place compacted pavement may also be determined by nuclear method in accordance with ASTM D2950/D2950M and coordinated with ASTM D1188 or ASTM D2726/D2726M.

F. Replace and compact hot-mix asphalt where core tests were taken.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.16 WASTE HANDLING

A. General: Handle asphalt-paving waste in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 32 12 16 00

Task	Specification	Specification Description
32 12 16 13	32 12 16 00	Asphalt Paving
32 12 16 19	32 12 16 00	Asphalt Paving
32 12 16 39	32 12 16 00	Asphalt Paving
32 12 16 43	32 12 16 00	Asphalt Paving
32 12 33 00	32 12 16 00	Asphalt Paving
32 12 36 13	32 12 16 00	Asphalt Paving
32 12 36 16	32 12 16 00	Asphalt Paving
32 12 73 00	32 13 13 00	Concrete Paving

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SECTION 32 13 13 00 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete paving[**.**][**including the following:**]

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. Section 321316 "Decorative Concrete Paving" for stamped concrete other than stamped detectable warnings.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
4. Section 321713 "Parking Bumpers."
5. Section 321716 "Manufactured Traffic-Calming Devices."
6. Section 321723 "Pavement Markings."
7. Section 321726 "Tactile Warning Surfacing" for detectable warning [**tiles**][**mats**][**and**][**pavers**].

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.
c. <**Insert agenda item**>.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.

c. Ready-mix concrete manufacturer.
d. Concrete paving Subcontractor.
e. Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Laboratory Test Reports: For concrete paving mixtures, documentation indicating that cured concrete complies with Solar Reflectance Index requirements.
12. Laboratory Test Reports: For concrete paving mixtures, documentation indicating that cured concrete complies with Solar Reflectance Index requirements.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

1. Exposed Aggregate: [**10-lb (4.5-kg)**]<**Insert weight**> Sample of each mix.

E. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified [**Installer of stamped detectable warnings**][**ready-mix concrete manufacturer**][**and**][**testing agency**].

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.

3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates:[**Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.**]

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than [**96 inches (2400 mm) by 96 inches (2400 mm)**]<**Insert dimensions**>.[**Include full-size detectable warning.**]
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below **40 deg F (4.4 deg C)**, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than **50 deg F (10 deg C)** and not more than **80 deg F (27 deg C)** at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with **ACI 301 (ACI 301M)** and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below **90 deg F (32 deg C)** at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms[**, steel reinforcement,**] and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of **100 feet (30.5 m)** or less.[**Do not use notched and bent forms.**]

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**]<**Insert value**> percent.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from [**as-**

drawn][**galvanized-**]steel wire into flat sheets.

C. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

D. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.

E. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

F. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars.

G. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars.

H. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars; assembled with clips.

I. Plain-Steel Wire: ASTM A1064/A1064M, [**as drawn**][**galvanized**].

J. Deformed-Steel Wire: ASTM A1064/A1064M.

K. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, [**plain**][**deformed**].

L. Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)** plain-steel bars[**; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating**]. Cut bars true to length with ends square and free of burrs.

M. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, **Grade 60 (Grade 420)** plain-steel bars.

N. Tie Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

O. Hook Bolts: **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

P. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

Q. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

R. Zinc Repair Material: ASTM A780/A780M.

2.4 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from

aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Concrete shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C150/C150M, [**gray**][**white**] portland cement [**Type I**][**Type II**][**Type I/II**][**Type III**][**Type V**].
2. Fly Ash: ASTM C618, [**Class C**][**or**][**Class F**].
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, portland-pozzolan**][**Type IL, Portland-limestone**][**Type IT, ternary blended**] cement.

G. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 4S**][**Class 4M**][**Class 1N**]<**Insert class**>, uniformly graded. Provide aggregates from a single source[**with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials**].

1. Maximum Coarse-Aggregate Size: [**1-1/2 inches (38 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**] nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

H. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: [**3/4 to 1 inch (19 to 25 mm)**][**1/2 to 3/4 inch (13 to 19 mm)**][**3/8 to 5/8 inch (10 to 16 mm)**]<**Insert dimensions**> nominal.
2. Aggregate Source, Shape, and Color: <**Insert requirements**>.

I. Air-Entraining Admixture: ASTM C260/C260M.

J. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

K. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alabama Pigments Company, LLC**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Dynamic Color Solutions, Inc**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Hoover Color Corporation**]
h. [**Lambert Corporation**]
i. [**Lanxess Corporation**]
j. [**Matcrete Inc.**]
k. [**NewLook International, Inc.**]
l. [**Proline Concrete Tools, Inc.**]
m. [**QC Construction Products**]
n. [**Scofield, a Business Unit of Sika Corporation**]
o. [**Solomon Colors Inc.**]
p. [**Stampcrete International, Ltd**]
q. [**SureCrete Design Products, a Fenix Group SPC Company**]
r. [**Venator Materials PLC**]
s. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alabama Pigments Company, LLC**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Dynamic Color Solutions, Inc**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Hoover Color Corporation**]
h. [**Lambert Corporation**]
i. [**Lanxess Corporation**]
j. [**Matcrete Inc.**]
k. [**NewLook International, Inc.**]
l. [**Proline Concrete Tools, Inc.**]
m. [**QC Construction Products**]
n. [**Scofield, a Business Unit of Sika Corporation**]
o. [**Solomon Colors Inc.**]
p. [**Stampcrete International, Ltd**]
q. [**SureCrete Design Products, a Fenix Group SPC Company**]
r. [**Venator Materials PLC**]
s. <**Insert manufacturer's name**>

3. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

L. Water: Potable and complying with ASTM C94/C94M.

2.5 FIBER REINFORCEMENT

A. Synthetic Fiber, Monofilament Fibers: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**]<**Insert dimensions**> long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

B. Synthetic Fiber, Fibrillated Fibers: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**]<**Insert dimensions**> long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2.6 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, [**Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry**][**or**][**cotton mats**].

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**Master Builders Solutions**]
j. [**Metalcrete Industries**]
k. [**Nox-Crete Products Group**]
l. [**Sika Corporation**]
m. [**SpecChem, LLC**]
n. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
o. [**Vexcon Chemicals Inc.**]
p. [**W. R. Meadows, Inc**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]

e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**Master Builders Solutions**]
j. [**Metalcrete Industries**]
k. [**Nox-Crete Products Group**]
l. [**Sika Corporation**]
m. [**SpecChem, LLC**]
n. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
o. [**Vexcon Chemicals Inc.**]
p. [**W. R. Meadows, Inc**]
q. <**Insert manufacturer's name**>

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Nox-Crete Products Group**]
i. [**Right Pointe**]
j. [**SpecChem, LLC**]
k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
l. [**Unitex; a Brand of Dayton Superior Corporation**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Nox-Crete Products Group**]
i. [**Right Pointe**]
j. [**SpecChem, LLC**]
k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
l. [**Unitex; a Brand of Dayton Superior Corporation**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]

o. <**Insert manufacturer's name**>

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**SpecChem, LLC**]
i. [**Vexcon Chemicals Inc.**]
j. [**W. R. Meadows, Inc**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**SpecChem, LLC**]
i. [**Vexcon Chemicals Inc.**]
j. [**W. R. Meadows, Inc**]
k. <**Insert manufacturer's name**>

2.7 RELATED MATERIALS

A. Joint Fillers: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**ASTM D1752, cork or self-expanding cork**][**or**][**ASTM D8139, semirigid, closed-cell polypropylene foam**] in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. [**Types I and II, nonload bearing**][**Types IV and V, load bearing**], for bonding hardened or

freshly mixed concrete to hardened concrete.

E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of **1/8 to 1/4 inch (3 to 6 mm)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ChemMasters, Inc**]
   b. [**Dayton Superior Corporation**]
   c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   d. [**Kaufman Products, Inc**]
   e. [**Nox-Crete Products Group**]
   f. [**QC Construction Products**]
   g. [**Scofield, a Business Unit of Sika Corporation**]
   h. [**Sika Corporation**]
   i. [**SpecChem, LLC**]
   j. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
   k. [**Vexcon Chemicals Inc.**]
   l. [**W. R. Meadows, Inc**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ChemMasters, Inc**]
   b. [**Dayton Superior Corporation**]
   c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   d. [**Kaufman Products, Inc**]
   e. [**Nox-Crete Products Group**]
   f. [**QC Construction Products**]
   g. [**Scofield, a Business Unit of Sika Corporation**]
   h. [**Sika Corporation**]
   i. [**SpecChem, LLC**]
   j. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
   k. [**Vexcon Chemicals Inc.**]
   l. [**W. R. Meadows, Inc**]
   m. <**Insert manufacturer's name**>

F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**Bon Tool Co.**]
   c. [**Brickform; a division of Solomon Colors**]

d. [**Butterfield Color, Inc.**]
e. [**Dayton Superior Corporation**]
f. [**Decosup Inc.**]
g. [**Dynamic Color Solutions, Inc**]
h. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**Kaufman Products, Inc**]
k. [**Lambert Corporation**]
l. [**Laticrete International, Inc.**]
m. [**Metalcrete Industries**]
n. [**Proline Concrete Tools, Inc.**]
o. [**QC Construction Products**]
p. [**Scofield, a Business Unit of Sika Corporation**]
q. [**Specialty Concrete Products, Inc**]
r. [**Stampcrete International, Ltd**]
s. [**Super Stone, Inc.**]
t. [**SureCrete Design Products, a Fenix Group SPC Company**]
u. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anti-Hydro International, Inc**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Dayton Superior Corporation**]
f. [**Decosup Inc.**]
g. [**Dynamic Color Solutions, Inc**]
h. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**Kaufman Products, Inc**]
k. [**Lambert Corporation**]
l. [**Laticrete International, Inc.**]
m. [**Metalcrete Industries**]
n. [**Proline Concrete Tools, Inc.**]
o. [**QC Construction Products**]
p. [**Scofield, a Business Unit of Sika Corporation**]
q. [**Specialty Concrete Products, Inc**]
r. [**Stampcrete International, Ltd**]
s. [**Super Stone, Inc.**]
t. [**SureCrete Design Products, a Fenix Group SPC Company**]
u. <**Insert manufacturer's name**>

3. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing **3/8-inch (9.5-mm)** sieve and 85 percent retained on a **No. 8 (2.36-mm)** sieve.

2.8 STAMPED DETECTABLE WARNING MATERIALS

A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advanced Surfaces Inc.**]
    b. [**Butterfield Color, Inc.**]
    c. [**Stampcrete International, Ltd**]
    d. [**Transpo Industries, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advanced Surfaces Inc.**]
    b. [**Butterfield Color, Inc.**]
    c. [**Stampcrete International, Ltd**]
    d. [**Transpo Industries, Inc.**]
    e. <**Insert manufacturer's name**>

3. Size of Stamp: One piece, [**matching detectable warning area shown on Drawings**][**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1220 mm)**][**26 by 26 inches (660 by 660 mm)**][**26 by 36 inches (660 by 914 mm)**]<**Insert dimensions**>.

B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advanced Surfaces Inc.**]
    b. [**Artcrete, Inc**]
    c. [**Bon Tool Co.**]
    d. [**Brickform; a division of Solomon Colors**]
    e. [**Butterfield Color, Inc.**]
    f. [**Decosup Inc.**]
    g. [**Matcrete Inc.**]
    h. [**Proline Concrete Tools, Inc.**]
    i. [**QC Construction Products**]
    j. [**Scofield, a Business Unit of Sika Corporation**]
    k. [**Specialty Concrete Products, Inc**]
    l. [**Stampcrete International, Ltd**]
    m. [**Super Stone, Inc.**]
    n. [**Venator Materials PLC**]
    o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advanced Surfaces Inc.**]

b. [**Artcrete, Inc**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Decosup Inc.**]
g. [**Matcrete Inc.**]
h. [**Proline Concrete Tools, Inc.**]
i. [**QC Construction Products**]
j. [**Scofield, a Business Unit of Sika Corporation**]
k. [**Specialty Concrete Products, Inc**]
l. [**Stampcrete International, Ltd**]
m. [**Super Stone, Inc.**]
n. [**Venator Materials PLC**]
o. <**Insert manufacturer's name**>

2.9 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to **ACI 301 (ACI 301M)**, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials:[**Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.**][**Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:**]

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.
3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content, **1-1/2-inch (38-mm)** Nominal Maximum Aggregate Size: [**5-1/2**][**4-1/2**][**2-1/2**] percent plus or minus 1-1/2 percent.
2. Air Content, **1-inch (25-mm)** Nominal Maximum Aggregate Size: [**6**][**4-1/2**][**3**] percent plus or minus 1-1/2 percent.
3. Air Content, **3/4-inch (19-mm)** Nominal Maximum Aggregate Size: [**6**][**5**][**3-1/2**] percent plus or minus 1-1/2 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**][**0.30**] percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use [**water-reducing admixture**][**high-range, water-reducing admixture**][**high-range, water-reducing and retarding admixture**][**plasticizing and retarding admixture**] in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**]<**Insert requirement**>.

G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

H. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): [**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**]<**Insert strength**>.
2. Maximum W/C Ratio at Point of Placement: [**0.45**][**0.50**]<**Insert ratio**>.
3. Slump Limit: [**4 inches (100 mm)**][**5 inches (125 mm)**][**8 inches (200 mm)**]<**Insert dimension**>, plus or minus **1 inch (25 mm)**.
4. Solar Reflectance Index: Not less than 29.
5. Solar Reflectance (SR): Three-year-aged SR value of at least 0.28 or initial SR of at least 0.33.
6. Solar Reflectance (SR): At least 0.30.
7. Solar Reflectance Index: At least 25.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M[**and ASTM C1116/C1116M**]. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between **85 and 90 deg F (30 and 32 deg C)**, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above **90 deg F (32 deg C)**, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below [**concrete paving**]<**Insert locations**> to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction[**and repeat in perpendicular direction**]. Limit vehicle speed to **3 mph (5 km/h)**.

2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of [**1/2 inch (13 mm)**]<**Insert dimension**> according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum **2-inch (50-mm)** overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless

otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use [**bonding agent**][**epoxy-bonding adhesive**] at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of [**50 feet (15.25 m)**]<**Insert dimension**> unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows[**, to match jointing of existing adjacent concrete paving**]:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] radius. Repeat grooving of contraction joints after applying surface finishes.[**Eliminate grooving-tool marks on concrete surfaces.**]

   a. Tolerance: Ensure that grooved joints are within [**3 inches (75 mm)**]<**Insert dimension**> either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3-mm-)** wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within [**3 inches (75 mm)**]<**Insert dimension**> either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] radius. Repeat tooling of edges after applying surface

finishes.[**Eliminate edging-tool marks on concrete surfaces.**]

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation[**, steel reinforcement,**] and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface[**and steel reinforcement**] before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with **ACI 301 (ACI 301M)** requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to **ACI 301 (ACI 301M)** by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies[**, reinforcement,**] or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating [**reinforcement**][**dowels**][**and**] joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface **1/16 to 1/8 inch (1.6 to 3 mm)** deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:

1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of **1/16 inch (1.6 mm)**.

1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread [**25 lb/100 sq. ft. (12 kg/10 sq. m)**][**40 lb/100 sq. ft. (19.5 kg/10 sq. m)**][**60 lb/100 sq. ft. (29 kg/10 sq. m)**]<**Insert rate of application**> of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

D. Rock-Salt Finish: After initial [**floating**][**troweling**][**brooming**], uniformly spread rock salt over paving surface at the rate of **5 lb/100 sq. ft. (0.2 kg/10 sq. m)**.

1. Embed rock salt into plastic concrete with [**roller**][**or**][**magnesium float**]<**Insert tool**>.
2. Cover paving surface with **1-mil- (0.025-mm-)** thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
3. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.

E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread dry-shake hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**]<**Insert rate of application**> unless greater amount is recommended by manufacturer to match paving color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
3. After final power floating, apply a hand-troweled finish followed by a broom finish.
4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 INSTALLATION OF DETECTABLE WARNINGS

A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 321726 "Tactile Warning Surfacing."

1. Tolerance for Opening Size: [**Plus 1/4 inch (6 mm), no minus**]<**Insert requirement**>.

B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

C. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.

1. Before using stamp mats, verify that the vent holes are unobstructed.
2. Apply liquid release agent to the concrete surface and the stamp mat.
3. Stamping: [**While initially finished concrete is plastic**][**After application and final floating of pigmented mineral dry-shake hardener**], accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
4. Trimming: After [**24**]<**Insert number**> hours, cut off the tips of mortar formed by the vent holes.
5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.10 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching **0.2 lb/sq. ft. x h (1 kg/sq. m x h)** before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by [**moisture curing**][**moisture-retaining-cover curing**][**curing compound**][**or**][**a combination of these**] as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with **12-inch (300-mm)** lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.11 PAVING TOLERANCES

A. Comply with tolerances in **ACI 117 (ACI 117M)** and as follows:

1. Elevation: **3/4 inch (19 mm)**.
2. Thickness: Plus **3/8 inch (10 mm)**, minus **1/4 inch (6 mm)**.
3. Surface: Gap below **10-feet- (3-m-)** long; unleveled straightedge not to exceed **1/2 inch (13 mm)**.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: **1/2 inch per 12 inches (13 mm per 300 mm)** of tie bar.
5. Lateral Alignment and Spacing of Dowels: **1 inch (25 mm)**.
6. Vertical Alignment of Dowels: **1/4 inch (6 mm)**.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: **1/4 inch per 12 inches (6 mm per 300 mm)** of dowel.
8. Joint Spacing: **3 inches (75 mm)**.
9. Contraction Joint Depth: Plus **1/4 inch (6 mm)**, no minus.
10. Joint Width: Plus **1/8 inch (3 mm)**, no minus.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each [100 cu. yd. (76 cu. m)][5000 sq. ft. (465 sq. m)] or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results to be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete

bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13 00

Task	Specification	Specification Description
32 13 13 33	32 13 13 00	Concrete Paving
32 13 13 33	32 13 16 00	Decorative Concrete Paving

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SECTION 32 13 16 00 - DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Colored concrete paving.
2. Stamped concrete paving.
3. Stenciled concrete paving.
4. Stained concrete paving.

B. Related Requirements:

1. [**Section 033000 "Cast-in-Place Concrete"**][**Section 033053 "Miscellaneous Cast-in-Place Concrete"**] for general building applications of concrete.
2. Section 321313 "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters, and stamped detectable warnings.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and other paving or adjacent construction.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and decorative concrete paving construction practices.
c. <**Insert agenda item**>.

2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Decorative concrete paving Installer.
e. Manufacturer's representative of decorative concrete paving system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color, pattern, or texture selection.

D. Samples for Verification: For each type of exposed color, pattern, or texture indicated.

E. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified [**Installer**][**ready-mix concrete manufacturer**][**and**][**testing agency**].

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates.[**Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.**]

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than [**96 inches (2400 mm) by 96 inches (2400 mm)**]<**Insert dimensions**>.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on decorative concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below **40 deg F (4.4 deg C)**, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than **50 deg F (10 deg C)** and not more than **80 deg F (27 deg C)** at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with **ACI 301 (ACI 301M)** and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below **90 deg F (32 deg C)** at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms[**, steel reinforcement,**] and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves of a radius of **100 feet (30.5 m)** or less. [**Do not use notched and bent forms.**]

B. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**]<**Insert value**> percent.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.

C. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

D. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars; assembled with clips.

E. Plain-Steel Wire: ASTM A1064/A1064M, as drawn.

F. Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)** plain-steel bars. Cut bars true to length with ends square and free of burrs.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater

compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Concrete shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

G. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, [**gray**][**white**] portland cement [**Type I**][**Type II**][**Type I/II**][**Type III**][**Type V**].
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, portland-pozzolan**][**Type IL, Portland-limestone**][**Type IT, ternary blended**] cement.

H. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 4S**][**Class 4M**][**Class 1N**]<**Insert class**>, uniformly graded. Provide aggregates from a single source[**with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials**].

1. Maximum Coarse-Aggregate Size: [**1-1/2 inches (38 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**]<**Insert dimension**> nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

I. Air-Entraining Admixture: ASTM C260/C260M.

J. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A[**, colored**].

2. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D[**, colored**].
3. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.

K. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alabama Pigments Company, LLC**]
    b. [**Bon Tool Co.**]
    c. [**Brickform; a division of Solomon Colors**]
    d. [**Butterfield Color, Inc.**]
    e. [**Dynamic Color Solutions, Inc**]
    f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    g. [**Hoover Color Corporation**]
    h. [**Lambert Corporation**]
    i. [**Lanxess Corporation**]
    j. [**Matcrete Inc.**]
    k. [**NewLook International, Inc.**]
    l. [**Proline Concrete Tools, Inc.**]
    m. [**QC Construction Products**]
    n. [**Scofield, a Business Unit of Sika Corporation**]
    o. [**Solomon Colors Inc.**]
    p. [**Stampcrete International, Ltd**]
    q. [**SureCrete Design Products, a Fenix Group SPC Company**]
    r. [**Venator Materials PLC**]
    s. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alabama Pigments Company, LLC**]
    b. [**Bon Tool Co.**]
    c. [**Brickform; a division of Solomon Colors**]
    d. [**Butterfield Color, Inc.**]
    e. [**Dynamic Color Solutions, Inc**]
    f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    g. [**Hoover Color Corporation**]
    h. [**Lambert Corporation**]
    i. [**Lanxess Corporation**]
    j. [**Matcrete Inc.**]
    k. [**NewLook International, Inc.**]
    l. [**Proline Concrete Tools, Inc.**]
    m. [**QC Construction Products**]
    n. [**Scofield, a Business Unit of Sika Corporation**]
    o. [**Solomon Colors Inc.**]
    p. [**Stampcrete International, Ltd**]
    q. [**SureCrete Design Products, a Fenix Group SPC Company**]
    r. [**Venator Materials PLC**]
    s. <**Insert manufacturer's name**>

L. Water: Potable and complying with ASTM C94/C94M.

2.5 FIBER REINFORCEMENT

A. Synthetic Fiber, Monofilament Fibers: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**]<**Insert dimensions**> long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

B. Synthetic Fiber, Fibrillated Fibers: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**]<**Insert dimensions**> long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2.6 SURFACE COLORING MATERIALS

A. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**Dynamic Color Solutions, Inc**]
i. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
j. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
k. [**Kaufman Products, Inc**]
l. [**Lambert Corporation**]
m. [**Laticrete International, Inc.**]
n. [**Metalcrete Industries**]
o. [**Proline Concrete Tools, Inc.**]
p. [**QC Construction Products**]
q. [**Scofield, a Business Unit of Sika Corporation**]
r. [**Specialty Concrete Products, Inc**]
s. [**Stampcrete International, Ltd**]
t. [**Super Stone, Inc.**]
u. [**SureCrete Design Products, a Fenix Group SPC Company**]
v. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anti-Hydro International, Inc**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]

f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**Dynamic Color Solutions, Inc**]
i. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
j. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
k. [**Kaufman Products, Inc**]
l. [**Lambert Corporation**]
m. [**Laticrete International, Inc.**]
n. [**Metalcrete Industries**]
o. [**Proline Concrete Tools, Inc.**]
p. [**QC Construction Products**]
q. [**Scofield, a Business Unit of Sika Corporation**]
r. [**Specialty Concrete Products, Inc**]
s. [**Stampcrete International, Ltd**]
t. [**Super Stone, Inc.**]
u. [**SureCrete Design Products, a Fenix Group SPC Company**]
v. <**Insert manufacturer's name**>

B. Pigmented Powder Release Agent: Factory-packaged, dry combination of surface-conditioning and dispersing agents interground with color pigments that facilitates release of stamp mats. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**Dynamic Color Solutions, Inc**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**Proline Concrete Tools, Inc.**]
k. [**QC Construction Products**]
l. [**Scofield, a Business Unit of Sika Corporation**]
m. [**Specialty Concrete Products, Inc**]
n. [**Stampcrete International, Ltd**]
o. [**Super Stone, Inc.**]
p. [**SureCrete Design Products, a Fenix Group SPC Company**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]

h. [**Dynamic Color Solutions, Inc**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**Proline Concrete Tools, Inc.**]
k. [**QC Construction Products**]
l. [**Scofield, a Business Unit of Sika Corporation**]
m. [**Specialty Concrete Products, Inc**]
n. [**Stampcrete International, Ltd**]
o. [**Super Stone, Inc.**]
p. [**SureCrete Design Products, a Fenix Group SPC Company**]
q. <**Insert manufacturer's name**>

C. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation that facilitates release of stamp mats and texture rollers.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Artcrete, Inc**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Decosup Inc.**]
g. [**Matcrete Inc.**]
h. [**Proline Concrete Tools, Inc.**]
i. [**QC Construction Products**]
j. [**Scofield, a Business Unit of Sika Corporation**]
k. [**Specialty Concrete Products, Inc**]
l. [**Stampcrete International, Ltd**]
m. [**Super Stone, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Artcrete, Inc**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Decosup Inc.**]
g. [**Matcrete Inc.**]
h. [**Proline Concrete Tools, Inc.**]
i. [**QC Construction Products**]
j. [**Scofield, a Business Unit of Sika Corporation**]
k. [**Specialty Concrete Products, Inc**]
l. [**Stampcrete International, Ltd**]
m. [**Super Stone, Inc.**]
n. <**Insert manufacturer's name**>

2.7 STAMPING DEVICES

A. Stamp Mats: Semirigid polyurethane mats with projecting textured and ridged underside capable of imprinting texture and joint patterns on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Matcrete Inc.**]
g. [**Proline Concrete Tools, Inc.**]
h. [**Scofield, a Business Unit of Sika Corporation**]
i. [**Specialty Concrete Products, Inc**]
j. [**Stampcrete International, Ltd**]
k. [**Super Stone, Inc.**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Matcrete Inc.**]
g. [**Proline Concrete Tools, Inc.**]
h. [**Scofield, a Business Unit of Sika Corporation**]
i. [**Specialty Concrete Products, Inc**]
j. [**Stampcrete International, Ltd**]
k. [**Super Stone, Inc.**]
l. <**Insert manufacturer's name**>

B. Stamp Tools: Open-grid, aluminum or rigid-plastic stamp tool capable of imprinting joint patterns on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Matcrete Inc.**]
b. [**Scofield, a Business Unit of Sika Corporation**]
c. [**Super Stone, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Matcrete Inc.**]
b. [**Scofield, a Business Unit of Sika Corporation**]
c. [**Super Stone, Inc.**]
d. <**Insert manufacturer's name**>

C. Rollers: Manually controlled, water-filled aluminum rollers with projecting ridges on drum capable of imprinting texture and joint patterns on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bon Tool Co.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bon Tool Co.**]
b. <**Insert manufacturer's name**>

D. Texture Rollers: Manually controlled, abrasion-resistant polyurethane rollers capable of imprinting texture on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Artcrete, Inc**]
b. [**Bon Tool Co.**]
c. [**Butterfield Color, Inc.**]
d. [**Proline Concrete Tools, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Artcrete, Inc**]
b. [**Bon Tool Co.**]
c. [**Butterfield Color, Inc.**]
d. [**Proline Concrete Tools, Inc.**]
e. <**Insert manufacturer's name**>

2.8 STENCIL MATERIALS

A. Stencils: Manufacturer's standard, moisture-resistant paper or reusable plastic stencils, designed for use on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Artcrete, Inc**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Specialty Concrete Products, Inc**]
f. [**SureCrete Design Products, a Fenix Group SPC Company**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Artcrete, Inc**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Specialty Concrete Products, Inc**]
f. [**SureCrete Design Products, a Fenix Group SPC Company**]
g. <**Insert manufacturer's name**>

2.9 STAIN MATERIALS

A. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**EPMAR Corporation; a Quaker Houghton company**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**QC Construction Products**]
k. [**Scofield, a Business Unit of Sika Corporation**]
l. [**Specialty Concrete Products, Inc**]
m. [**Stampcrete International, Ltd**]
n. [**Super Stone, Inc.**]
o. [**SureCrete Design Products, a Fenix Group SPC Company**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Americrete, Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**EPMAR Corporation; a Quaker Houghton company**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**QC Construction Products**]
k. [**Scofield, a Business Unit of Sika Corporation**]
l. [**Specialty Concrete Products, Inc**]
m. [**Stampcrete International, Ltd**]
n. [**Super Stone, Inc.**]
o. [**SureCrete Design Products, a Fenix Group SPC Company**]
p. <**Insert manufacturer's name**>

B. Penetrating Stain: Water-based, acrylic latex, penetrating stain with colorfast pigments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**AmeriPolish**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Duckback Products**]
h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**Super Stone, Inc.**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Americrete, Inc.**]
b. [**AmeriPolish**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Duckback Products**]
h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**Super Stone, Inc.**]
k. <**Insert manufacturer's name**>

2.10 CURING AND SEALING MATERIALS

A. Curing Paper: Nonstaining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C171.

B. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**Metalcrete Industries**]
j. [**Nox-Crete Products Group**]
k. [**Sika Corporation**]
l. [**SpecChem, LLC**]
m. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
n. [**Vexcon Chemicals Inc.**]
o. [**W. R. Meadows, Inc**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**Metalcrete Industries**]
j. [**Nox-Crete Products Group**]
k. [**Sika Corporation**]
l. [**SpecChem, LLC**]
m. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
n. [**Vexcon Chemicals Inc.**]
o. [**W. R. Meadows, Inc**]
p. <**Insert manufacturer's name**>

C. Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, nondissipating, non-yellowing, manufactured for use with colored concrete.

1. Curing compound shall be pigmented type matching color of integrally colored concrete and shall be approved by coloring admixture manufacturer.

2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anti-Hydro International, Inc**]
    b. [**ChemMasters, Inc**]
    c. [**Dayton Superior Corporation**]
    d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    e. [**Kaufman Products, Inc**]
    f. [**Lambert Corporation**]
    g. [**Laticrete International, Inc.**]
    h. [**Metalcrete Industries**]
    i. [**Nox-Crete Products Group**]
    j. [**SpecChem, LLC**]
    k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
    l. [**Vexcon Chemicals Inc.**]
    m. [**W. R. Meadows, Inc**]
    n. <**Insert manufacturer's name**>

4. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Anti-Hydro International, Inc**]
    b. [**ChemMasters, Inc**]
    c. [**Dayton Superior Corporation**]
    d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    e. [**Kaufman Products, Inc**]
    f. [**Lambert Corporation**]
    g. [**Laticrete International, Inc.**]
    h. [**Metalcrete Industries**]
    i. [**Nox-Crete Products Group**]
    j. [**SpecChem, LLC**]
    k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
    l. [**Vexcon Chemicals Inc.**]
    m. [**W. R. Meadows, Inc**]
    n. <**Insert manufacturer's name**>

D. High-Solids, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating, non-yellowing, manufactured for use with colored concrete.

1. Curing compound shall be pigmented type matching color of integrally colored concrete and shall be approved by coloring admixture manufacturer.
2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ChemMasters, Inc**]
    b. [**Dayton Superior Corporation**]
    c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    d. [**Kaufman Products, Inc**]

e. [**Lambert Corporation**]
f. [**Laticrete International, Inc.**]
g. [**Metalcrete Industries**]
h. [**Nox-Crete Products Group**]
i. [**SpecChem, LLC**]
j. [**V-Seal Concrete Sealers & Specialty Coatings**]
k. [**Vexcon Chemicals Inc.**]
l. [**W. R. Meadows, Inc**]
m. <**Insert manufacturer's name**>

4. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ChemMasters, Inc**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**Lambert Corporation**]
f. [**Laticrete International, Inc.**]
g. [**Metalcrete Industries**]
h. [**Nox-Crete Products Group**]
i. [**SpecChem, LLC**]
j. [**V-Seal Concrete Sealers & Specialty Coatings**]
k. [**Vexcon Chemicals Inc.**]
l. [**W. R. Meadows, Inc**]
m. <**Insert manufacturer's name**>

E. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A, manufactured for use with colored concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**Right Pointe**]
k. [**SpecChem, LLC**]
l. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**Right Pointe**]
k. [**SpecChem, LLC**]
l. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]
o. <**Insert manufacturer's name**>

3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A, manufactured for use with colored concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**Right Pointe**]
k. [**SpecChem, LLC**]
l. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]

o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**Right Pointe**]
k. [**SpecChem, LLC**]
l. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]
o. <**Insert manufacturer's name**>

3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Clear Acrylic Sealer, Low-to-Medium Gloss: Manufacturer's standard, waterborne, non-yellowing and UV-resistant, membrane-forming, acrylic copolymer emulsion or epoxy-modified acrylic emulsion, manufactured for colored concrete, containing not less than 15 percent solids by volume.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Concrete Sealers USA**]
d. [**Duckback Products**]
e. [**EPMAR Corporation; a Quaker Houghton company**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**QC Construction Products**]

i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**United Gilsonite Laboratories (UGL)**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Concrete Sealers USA**]
d. [**Duckback Products**]
e. [**EPMAR Corporation; a Quaker Houghton company**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**QC Construction Products**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**United Gilsonite Laboratories (UGL)**]
k. <**Insert manufacturer's name**>

H. Clear Acrylic Sealer, High Gloss: Manufacturer's standard, waterborne, non-yellowing and UV-resistant, membrane-forming, high-gloss, acrylic copolymer emulsion solution, manufactured for colored concrete, containing not less than 25 percent solids by volume.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Concrete Sealers USA**]
d. [**Duckback Products**]
e. [**EPMAR Corporation; a Quaker Houghton company**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**Scofield, a Business Unit of Sika Corporation**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Concrete Sealers USA**]
d. [**Duckback Products**]
e. [**EPMAR Corporation; a Quaker Houghton company**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**Scofield, a Business Unit of Sika Corporation**]
i. <**Insert manufacturer's name**>

I. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving

surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advanced Surfaces Inc.**]
    b. [**Bomanite Co**]
    c. [**Bon Tool Co.**]
    d. [**Dayton Superior Corporation**]
    e. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
    f. [**QC Construction Products**]
    g. [**Vexcon Chemicals Inc.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advanced Surfaces Inc.**]
    b. [**Bomanite Co**]
    c. [**Bon Tool Co.**]
    d. [**Dayton Superior Corporation**]
    e. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
    f. [**QC Construction Products**]
    g. [**Vexcon Chemicals Inc.**]
    h. <**Insert manufacturer's name**>

2.11 RELATED MATERIALS

A. Joint Fillers: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**ASTM D1752, cork or self-expanding cork**][**or**][**ASTM D8139, semirigid, closed-cell polypropylene foam**] in preformed strips.

B. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

    1. [**Types I and II, nonload bearing**][**Types IV and V, load bearing**], for bonding hardened or freshly mixed concrete to hardened concrete.

D. Polyethylene Film: ASTM D4397, **1 mil (0.025 mm)** thick, clear.

2.12 CONCRETE MIXTURES

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures, proportioned according to **ACI 301 (ACI 301M)**, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

C. Cementitious Materials:[**Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.**][**Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:**]

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.
3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content:

a. [**5-1/2**][**4-1/2**][**2-1/2**] percent plus or minus 1.5 percent for **1-1/2-inch (38-mm)** nominal maximum aggregate size.
b. [**6**][**4-1/2**][**3**] percent plus or minus 1.5 percent for **1-inch (25-mm)** nominal maximum aggregate size.
c. [**6**][**5**][**3-1/2**] percent plus or minus 1.5 percent for **3/4-inch (19-mm)** nominal maximum aggregate size.

E. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**][**0.30**] percent by weight of cement.

F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use [**water-reducing admixture**][**water-reducing and retarding admixture**][**water-reducing and accelerating admixture**] in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than [**1.0 lb/cu. yd. (0.60 kg/cu. m)**]<**Insert requirement**>.

H. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

I. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): [**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**]<**Insert strength**>.
2. Maximum W/C Ratio at Point of Placement: [**0.45**][**0.50**]<**Insert ratio**>.
3. Slump Limit: [**4 inches (100 mm)**][**5 inches (125 mm)**]<**Insert dimension**>, plus or minus **1 inch (25 mm)**.

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M[**and ASTM C1116/C1116M**]. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between **85 and 90 deg F (30 and 32 deg C)**, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above **90 deg F (32 deg C)**, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below [**decorative concrete paving**]<**Insert locations**> to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction[**and repeat in perpendicular direction**]. Limit vehicle speed to **3 mph (5 km/h)**.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of [**1/2 inch (13 mm)**]<**Insert dimension**> according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum **2-inch (50-mm)** overlap to adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Butt Joints: Use [**bonding agent**][**epoxy-bonding adhesive**] at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of [**50 feet (15.25 m)**]<**Insert dimension**> unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows[**, to match jointing of existing adjacent decorative concrete paving**]:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

   a. Tolerance: Ensure that grooved joints are within [**3 inches (75 mm)**]<**Insert dimension**> either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3-mm-)** wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within [**3 inches (75 mm)**]<**Insert dimension**> in both directions from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation[**, steel reinforcement,**] and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface[**and steel reinforcement**] before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with **ACI 301 (ACI 301M)** requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to **ACI 301 (ACI 301M)** by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies[**, reinforcement,**] or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating [**reinforcement**][**dowels**][**and**] joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.8 INTEGRALLY COLORED CONCRETE FINISH

A. Integrally Colored Concrete Finish: After final floating, apply the following finish:

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface **1/16 to 1/8 inch (1.6 to 3 mm)** deep with a stiff-bristled broom, perpendicular to line of traffic.

3.9 STENCILING

A. Cut stencils to slab width and lay on wet concrete. Overlap "mortar joint" on trailing edge of each section of stencil onto leading "mortar joint" of previous section.

B. Trim stencils to fit slab and adjacent patterns.

C. Slightly embed stencil into concrete by rolling with stencil roller.

D. Apply pigmented mineral dry-shake hardener materials to concrete surfaces according to manufacturer's written instructions.

E. Stencil Rolling:

1. Apply [**pigmented powder release agent**][**liquid release agent**] according to manufacturer's written instructions prior to applying texture roller to surface of concrete.
2. Perform rolling operation to produce required texture on concrete surface.

F. Remove stencils when concrete has sufficiently cured to bear weight. Do not leave stencils in concrete overnight.

G. Remove debris with mechanical blower prior to application of curing compound. If release agent is applied, delay removal of debris for 24 hours, then flood area with low-pressure water hose, wetting release agent, and follow by cleaning surface with pressure washer.

3.10 PIGMENTED MINERAL DRY-SHAKE HARDENER APPLICATION

A. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**]<**Insert rate of application**> unless greater amount is recommended by manufacturer to match paving color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
3. After final power floating, apply the following finish:

a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
b. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface **1/16 to 1/8 inch (1.6 to 3 mm)** deep with a stiff-bristled broom, perpendicular to line of traffic.

B. Pigmented Powder Release Agent: Uniformly distribute onto dry-shake-hardened and still-plastic concrete at a rate of **3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m)**.

C. Liquid Release Agent: Uniformly mist surface of dry-shake-hardened and still-plastic concrete at a rate of **5 gal/1000 sq. ft. (0.2 L/sq. m)**.

3.11 STAMPING

A. Mat Stamping: After floating and while concrete is plastic, apply mat-stamped finish.

1. Pigmented Powder Release Agent: Uniformly distribute onto concrete at a rate of **3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m)**.
2. Liquid Release Agent: Apply liquid release agent to the concrete surface and the stamp mat. Uniformly mist surface of concrete at a rate of **5 gal/1000 sq. ft. (0.2 L/sq. m)**.
3. After application of release agent, accurately align and place stamp mats in sequence.
4. Uniformly load mats and press into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp mats. Hand stamp edges and surfaces unable to be imprinted by stamp mats.
5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

B. Tool Stamping: After floating and while concrete is plastic, apply tool-stamped finish.

1. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends **3 inches (75 mm)**, and secure to edge forms. Lightly broom surface to remove air bubbles.
2. Accurately align and place stamp tools in sequence and tamp into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp tools. Hand stamp edges and surfaces unable to be imprinted by stamp tools.
3. Carefully remove polyethylene film immediately after tool stamping.

C. Roller Stamping: After floating and while concrete is plastic, apply roller-stamped finish.

1. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends **3 inches (75 mm)**, and secure to edge forms. Lightly broom surface to remove air bubbles.
2. Accurately align roller and perform rolling operation to produce required imprint pattern and depth of imprint on concrete surface. Hand stamp surfaces inaccessible to roller.
3. Carefully remove polyethylene film immediately after roller stamping.

3.12 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching **0.2 lb/sq. ft. x h (1 kg/sq. m x h)** before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Compound: Apply immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

1. Cure integrally colored concrete with a[**pigmented**] curing compound.
2. Cure concrete finished with pigmented mineral dry-shake hardener with a[**pigmented**] curing compound.

F. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

G. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

3.13 STAINING

A. Newly placed concrete paving shall be at least [**14**][**30**]<**Insert number**> days old before staining.

B. Prepare surfaces according to manufacturer's written instructions and as follows:

1. Clean concrete thoroughly by scraping, applying solvents or stripping agents, sweeping and pressure washing, or scrubbing with a rotary floor machine and detergents recommended by stain manufacturer. Rinse until water is clear and allow surface to dry.

    a. Do not use acidic solutions to clean surfaces.

2. Test surfaces with droplets of water. If water beads and does not penetrate surface, or penetrates only in some areas, profile surfaces by [**acid etching**][**grinding, sanding, or abrasive blasting**].

Retest and continue profiling surface until water droplets immediately darken and uniformly penetrate concrete surfaces.

3. Apply acidic solution to dampened concrete surfaces, scrubbing with uncolored, acid-resistant nylon-bristle brushes until bubbling stops and concrete surface has texture of 120-grit sandpaper. Do not allow solution to dry on concrete surfaces. Rinse until water is clear. Control, collect, and legally dispose of runoff.
4. Neutralize concrete surfaces and rinse until water is clear. Test surface for residue with clean white cloth. Test surface according to ASTM F710 to ensure pH is between [**7 and 8**]<**Insert values**>.

C. Scoring: Score decorative jointing in paving surfaces **1/16 inch (1.6 mm)** deep with diamond blades to match pattern indicated. Rinse until water is clear. Score [**after**][**before**] staining.

1. Joint Width: [**3/8 inch (10 mm)**]<**Insert dimension**>.

D. Allow paving surface to dry before applying stain. Verify readiness of paving to receive stain according to ASTM D4263 by tightly taping **18-by-18-inch (450-by-450-mm)**, **4-mil- (0.1-mm-)** thick polyethylene sheet to a representative area of paving surface. Apply stain only if no evidence of moisture has accumulated under sheet after 16 hours.

E. Reactive Stain: Apply reactive stain to paving surfaces according to manufacturer's written instructions and as follows:

1. Apply stain by uncolored bristle brush, roller, or high-volume, low-pressure sprayer and immediately scrub into concrete surface with uncolored, acid-resistant nylon-bristle brushes in continuous, circular motion. Do not spread stain after fizzing stops. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
2. Remove stain residue after four hours by wet scrubbing with commercial-grade detergent recommended by stain manufacturer. Rinse until water is clear. Control, collect, and legally dispose of runoff.

F. Penetrating Stain: Apply to paving surfaces according to manufacturer's written instructions and as follows:

1. Apply first coat of stain to dry, clean surfaces by airless sprayer or by high-volume, low-pressure sprayer.
2. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
3. Rinse until water is clear. Control, collect, and legally dispose of runoff.

3.14 SEALER APPLICATION

A. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat, using same application methods and rates.

1. Begin sealing dry surface no sooner than [**14**]<**Insert number**> days after concrete placement.
2. Allow stained concrete surfaces to dry before applying sealer.
3. Thoroughly mix slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

3.15 PAVING TOLERANCES

A. Comply with tolerances in **ACI 117 (ACI 117M)** and as follows:

1. Elevation: **3/4 inch (19 mm)**.
2. Thickness: Plus **3/8 inch (10 mm)**, minus **1/4 inch (6 mm)**.
3. Surface: Gap below **10-foot- (3-m-)** long, unleveled straightedge not to exceed **1/2 inch (13 mm)**.
4. Lateral Alignment and Spacing of Dowels: **1 inch (25 mm)**.
5. Vertical Alignment of Dowels: **1/4 inch (6 mm)**.
6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: **1/4 inch per 12 inches (6 mm per 300 mm)** of dowel.
7. Joint Spacing: **3 inches (75 mm)**.
8. Contraction Joint Depth: Plus **1/4 inch (6 mm)**, no minus.
9. Joint Width: Plus **1/8 inch (3 mm)**, no minus.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each [**100 cu. yd. (76 cu. m)**][**5000 sq. ft. (465 sq. m)**] or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is **40 deg F (4.4 deg C)** and below and when it is **80 deg F (27 deg C)** and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than **500 psi (3.4 MPa)**.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of

concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Decorative concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.17 REPAIR AND PROTECTION

A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.

C. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

3.18 DECORATIVE CONCRETE PAVING SCHEDULE

A. Patterned Decorative Concrete Paving :

1. Locations: Install at [**drives**][**parking lots**][**walks**][**patios**][**and**][**swimming pool decks**]<**Insert location**>.
2. Coloring Method: [**Integrally colored**][**Pigmented mineral dry-shake hardener**].
    a. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.
3. Field Patterning Method: [**Stamped**][**Stenciled**].
    a. Texture and Pattern: [**Keystone installed at 45-degrees diagonal to main lines of building**]<**Insert requirement**>.
    b. Pigmented Mineral Dry-Shake Hardener: <**Insert color**>.
    c. Release Agent: [**Match pigmented mineral dry-shake hardener**]<**Insert color**>.
4. Border and Accent Strip Patterning Method: [**Stamped**][**Stenciled**].

a. Texture and Pattern: <**Insert requirement**>.
b. Pigmented Mineral Dry-Shake Hardener: <**Insert color**>.
c. Release Agent: [**Match pigmented mineral dry-shake hardener**]<**Insert color**>.

B. Stained Decorative Concrete Paving :

1. Locations: Install at [**drives**][**parking lots**][**walks**][**patios**][**and**][**swimming pool decks**]<**Insert location**>.
2. Staining Method: [**Reactive**][**Penetrating**] stain.
3. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

END OF SECTION 32 13 16 00

Task	Specification	Specification Description
32 13 16 13	32 13 13 00	Concrete Paving
32 13 16 13	32 13 16 00	Decorative Concrete Paving
32 13 43 00	32 13 13 00	Concrete Paving

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SECTION 32 13 73 00 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.
3. Cold-applied, fuel-resistant joint sealants.
4. Hot-applied, fuel-resistant joint sealants.
5. Joint-sealant backer materials.
6. Primers.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Concrete pavement joint sealants.
2. Joint-sealant backer materials.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.

C. Samples for Verification: Actual sample of finished products for each kind and color of joint sealant required.

1. Size: Joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**Installer**][**testing agency**].

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Performed by a qualified testing agency.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below 40 deg F (5 deg C)**].
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer[**for each sealant type**].

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; RoadSaver Silicone.
b. Pecora Corporation; 301 NS.
c. The Dow Chemical Company; Dow Corning 888 Silicone Joint Sealant.
d. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]
b. [**Pecora Corporation**]
c. [**The Dow Chemical Company**]
d. <**Insert manufacturer's name**>

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; RoadSaver Silicone SL.
b. Pecora Corporation; [**300 SL**][**322FC**].
c. The Dow Chemical Company; Dow Corning 890-SL Silicone Joint Sealant.
d. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]
b. [**Pecora Corporation**]
c. [**The Dow Chemical Company**]
d. <**Insert manufacturer's name**>

C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. W.R. Meadows, Inc; Pourthane NS.
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**W. R. Meadows, Inc**]
b. <**Insert manufacturer's name**>

D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not**

limited to, the following]:

a. W.R. Meadows, Inc; Pourthane SL.
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**W. R. Meadows, Inc**]
b. <**Insert manufacturer's name**>

E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Pecora Corporation; [**Dynatred**][**Dynatrol II-SG**][**Urexpan NR-200**].
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Pecora Corporation**]
b. <**Insert manufacturer's name**>

2.4 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant, Type I: ASTM D6690.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; [**Asphalt Rubber Plus**][**Asphalt Rubber Plus Type 2**][**RoadSaver 203**][**RoadSaver 211**][**RoadSaver 515**].
b. Right Pointe; JTS Asphalt Rubber Modified 043.
c. W.R. Meadows, Inc; [**Sealtight 1190**][**Sealtight 164**].
d. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]
b. [**Right Pointe**]
c. [**W. R. Meadows, Inc**]
d. <**Insert manufacturer's name**>

B. Hot-Applied, Single-Component Joint Sealant, Type I or Type II: ASTM D6690.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. Crafco Inc.; [**RoadSaver 201**][**RoadSaver 220**][**RoadSaver 221**][**RoadSaver 534**].
    b. Right Pointe; [**JTS 3405 Parking Lot Sealant 007**][**JTS 3405 Rubber 009**].
    c. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crafco Inc**]
    b. [**Right Pointe**]
    c. <**Insert manufacturer's name**>

C. Hot-Applied, Single-Component Joint Sealant, Type I, II, or III: ASTM D6690.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. Crafco Inc.; RoadSaver 222.
    b. Right Pointe; [**JTS 3405 Regular 003**][**JTS 3405 Rubber 009**].
    c. W.R. Meadows, Inc; Sealtight 3405.
    d. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crafco Inc**]
    b. [**Right Pointe**]
    c. [**W. R. Meadows, Inc**]
    d. <**Insert manufacturer's name**>

D. Hot-Applied, Single-Component Joint Sealant, Type IV: ASTM D6690.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. Crafco Inc.; RoadSaver 231.
    b. W.R. Meadows, Inc; Sealtight 3405M.
    c. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crafco Inc**]
    b. [**W. R. Meadows, Inc**]
    c. <**Insert manufacturer's name**>

2.5 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. BASF Corporation; MasterSeal CR 125 (Pre-2014: Sonomeric 1).
   b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. <**Insert manufacturer's name**>

B. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Pecora Corporation; <**Insert product name or designation**>.
   b. W.R. Meadows, Inc; <**Insert product name or designation**>.
   c. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Pecora Corporation**]
   b. [**W. R. Meadows, Inc**]
   c. <**Insert manufacturer's name**>

2.6 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants, Type I or Type II: ASTM D7116.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Crafco Inc.; [**Superseal 1614A**][**Superseal 444/777**].
   b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Crafco Inc**]

b. <**Insert manufacturer's name**>

B. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants, Type III: ASTM D7116.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; Superseal Low-Mod.
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]
b. <**Insert manufacturer's name**>

2.7 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.8 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backer materials.
2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joints within concrete paving[**PJS-#**]:

1. Joint Location:

   a. Expansion and isolation joints in concrete paving.
   b. Contraction joints in concrete paving.
   c. Other joints as indicated.

2. Joint Sealant: [**Single-component, nonsag, silicone joint sealant**][**Single-component, self-leveling, silicone joint sealant**][**Multicomponent, nonsag, urethane, elastomeric joint sealant**][**Single component, pourable, urethane, elastomeric joint sealant**][**Multicomponent, pourable, urethane, elastomeric joint sealant**][**Hot-applied, single-component joint sealant**]<**Insert joint sealant**>.
3. Joint-Sealant Color: [**Manufacturer's standard**]<**Insert color**>.

B. Joints within concrete paving and between concrete and asphalt paving[**PJS-#**]:

1. Joint Location:

   a. Joints between concrete and asphalt paving.
   b. Joints between concrete curbs and asphalt paving.
   c. Other joints as indicated.

2. Joint Sealant: [**Hot-applied, single-component joint sealant**]<**Insert joint sealant**>.
3. Joint-Sealant Color: [**Manufacturer's standard**]<**Insert color**>.

C. Fuel-resistant joints within concrete paving[**PJS-#**]:

1. Joint Location:

   a. Expansion and isolation joints in concrete paving.
   b. Contraction joints in concrete paving.
   c. Other joints as indicated.

2. Joint Sealant: [**Fuel-resistant, single-component, pourable, modified-urethane, elastomeric joint sealant**][**Fuel-resistant, multicomponent, pourable, modified-urethane, elastomeric joint sealant**][**Hot-applied, fuel-resistant, single-component joint sealant**]<**Insert joint sealant**>.
3. Joint-Sealant Color: [**Manufacturer's standard**]<**Insert color**>.

END OF SECTION 32 13 73 00

Task	Specification	Specification Description
32 13 73 13	32 13 73 00	Concrete Paving Joint Sealants
32 13 73 16	32 12 16 00	Asphalt Paving
32 13 73 16	32 13 73 00	Concrete Paving Joint Sealants
32 13 73 19	32 12 16 00	Asphalt Paving
32 13 73 19	32 13 73 00	Concrete Paving Joint Sealants

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SECTION 32 14 00 00 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick pavers.
2. Concrete pavers.
3. Asphalt-block pavers.
4. Stone pavers.
5. Curbs and edge restraints.

B. Related Requirements:

1. [**Section 075113 "Built-up Asphalt Roofing"**][**Section 075116 "Built-up Coal Tar Roofing"**][**Section 075213 "Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing"**][**Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing"**][**Section 075316 "Chlorosulfonate-Polyethylene (CSPE) Roofing"**][**Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing"**][**Section 075416 "Ketone Ethylene Ester (KEE) Roofing"**][**Section 075419 "Polyvinyl-Chloride (PVC) Roofing"**][**Section 075423 "Thermoplastic Polyolefin (TPO) Roofing"**][**Section 075552.13 "Atactic-Polypropylene (APP) Modified Bituminous Protected Membrane Roofing"**][**Section 075552.16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Protected Membrane Roofing"**][**Section 075556 "Fluid-Applied Protected Membrane Roofing"**] for roof pavers.
2. Section 096313 "Brick Flooring" for brick flooring for interior applications.
3. Section 096340 "Stone Flooring" for dimension stone paving.
4. Section 321216 "Asphalt Paving" for asphalt base under unit pavers.
5. Section 321313 "Concrete Paving" [**for concrete base under unit pavers**][**and**][**for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers**].
6. Section 321443 "Porous Unit Paving" for unit paving using grid pavers or pavers with openings between them.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:

a. Pavers.
b. Bituminous setting materials.
c. Mortar and grout materials.
d. Edge restraints.
e. Precast concrete curbs.

f. Granite curbs.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

D. Samples for Initial Selection: For each type of unit paver indicated[**.**][**and the following:**]

1. Joint materials involving color selection.
2. Exposed edge restraints involving color selection.
3. Precast concrete curbs.
4. Granite curbs.

E. Samples for Verification: For full-size units of each type of unit paver indicated.[**Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints.**][**Include Samples of the following:**]

1. Joint materials.
2. Exposed edge restraints.
3. Precast concrete curbs.
4. Granite curbs.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

C. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified unit paving installer. Installer's [**field supervisor**][**personnel assigned to the Work**] must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with [**one of**][**both of**] the following designations:

1. Residential Paver Technician Designation.
2. Commercial Paver Technician Designation.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.8 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above **40 deg F (4 deg C)** and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above **50 deg F (10 deg C)** and when temperature has not been below **35 deg F (2 deg C)** for 12 hours immediately before application.

Do not apply when setting bed is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of **100 deg F (38 deg C)** and higher.

a. When ambient temperature exceeds **100 deg F (38 deg C)**, or when wind velocity exceeds **8 mph (13 km/h)** and ambient temperature exceeds **90 deg F (32 deg C)**, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 BRICK PAVERS

A. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Brick shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Brick Pavers, Light-Traffic Paving Brick: ASTM C902, Class SX[**or Class MX**], [**Type I**][**Type II**][**Type III**], Application [**PS**][**PX**][**PA**]. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Thickness: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-5/8 inches (41 mm)**][**2-1/4 inches (57 mm)**][**2-5/8 inches (67 mm)**][**As indicated**]<**Insert dimension**>.
2. Face Size: [**3-3/4 by 7-1/2 inches (95 by 190 mm)**][**3-5/8 by 7-5/8 inches (92 by 194 mm)**][**3-5/8**

by 11-5/8 inches (92 by 295 mm)][7-5/8 by 7-5/8 inches (194 by 194 mm)][4 by 8 inches (102 by 203 mm)][4 by 12 inches (102 by 305 mm)][8 by 8 inches (203 by 203 mm)][**As indicated**]<**Insert dimensions**>.

3. Color: [**Dark red**][**Medium red**][**Full-range red**][**Dark brown**][**Medium brown**][**Full-range brown**][**Tan**][**Buff**][**Cream**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

G. Brick Pavers, Heavy Vehicular Paving Brick: ASTM C1272, [**Type F, Application PX**][**Type R, Application PS**][**Type R, Application PX**][**Type R, Application PA**]. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Thickness: [2-1/4 inches (57 mm)][2-5/8 inches (67 mm)][**As indicated**]<**Insert dimension**>.
2. Face Size: [3-3/4 by 7-1/2 inches (95 by 190 mm)][3-5/8 by 7-5/8 inches (92 by 194 mm)][3-5/8 by 11-5/8 inches (92 by 295 mm)][7-5/8 by 7-5/8 inches (194 by 194 mm)][4 by 8 inches (102 by 203 mm)][4 by 12 inches (102 by 305 mm)][8 by 8 inches (203 by 203 mm)][**As indicated**]<**Insert dimensions**>.
3. Color: [**Dark red**][**Medium red**][**Full-range red**][**Dark brown**][**Medium brown**][**Full-range brown**][**Tan**][**Buff**][**Cream**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

H. Efflorescence: Brick to be rated "not effloresced" when tested according to ASTM C67.

I. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

2.3 CONCRETE PAVERS

A. Regional Materials: Concrete pavers shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

B. Regional Materials: Concrete pavers shall be manufactured within 500 miles (800 km) of Project site.

C. Regional Materials: Concrete pavers shall be manufactured within 100 miles (160 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

D. Indigenous Materials: Concrete pavers shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Concrete pavers shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Concrete Pavers, Solid Interlocking Paving Units: Complying with ASTM C936/C936M[**and resistant to freezing and thawing when tested according to ASTM C67**], made from normal-weight aggregates.

1. Thickness: [**2-3/8 inches (60 mm)**][**3-1/8 inches (80 mm)**]<**Insert dimension**>.
2. Face Size and Shape:

    a. [**3-7/8 inches (98 mm)**][**4-7/16 inches (113 mm)**][**8-7/8 inches (225 mm)**][**9 inches (229 mm)**] square.
    b. [**3-7/8-by-7-7/8-inch (98-by-200-mm)**][**4-by-8-inch (102-by-203-mm)**][**4-7/16-by-8-7/8-inch (113-by-225-mm)**] rectangle.
    c. [**5-1/2-inch (140-mm) octagon with attached 3-1/2-inch (89-mm) square**][**4-1/2-by-9-inch (114-by-229-mm) rectangle with saw-tooth edges**][**4-3/4-inch (121-mm) rectangular and trapezoidal units arranged in semicircular courses to produce fan-shaped pattern**][**As indicated**]<**Insert dimensions and shape**>.

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

G. Concrete Pavers, Solid Paving Units, Normal-Weight Concrete: Solid paving units made from normal-weight concrete with a compressive strength not less than [**5000 psi (34 MPa)**][**6000 psi (41 MPa)**]<**Insert value**>, water absorption not more than 5 percent according to ASTM C140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67.

1. Thickness: [**1-5/8 inches (41 mm)**][**1-3/4 inches (45 mm)**][**2 inches (51 mm)**][**2-3/8 inches (60 mm)**]<**Insert dimension**>.
2. Face Size and Shape:

    a. [**8-7/8 inches (225 mm)**][**9 inches (229 mm)**][**12 inches (305 mm)**][**18 inches (457 mm)**][**24 inches (610 mm)**] square.
    b. [**9-by-18-inch (229-by-457-mm)**][**12-by-24-inch (305-by-610-mm)**] rectangle.
    c. [**As indicated**]<**Insert dimensions and shape**>.

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

H. Concrete Pavers, Solid Paving Units, Lightweight Concrete: Solid paving units complying with ASTM C1491, made from lightweight concrete.

1. Thickness: [**1-5/8 inches (41 mm)**][**1-3/4 inches (45 mm)**][**2 inches (51 mm)**]<**Insert dimension**>.
2. Face Size and Shape: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**As indicated**]<**Insert dimensions and shape**>.
3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

2.4 ASPHALT-BLOCK PAVERS

A. Asphalt-Block Pavers: Solid units made from asphalt cement complying with ASTM D312, Type III; inorganic stone dust or cement filler; and coarse aggregate, consisting of clean, hard, unweathered stone crushed into angular particles varying in size up to **3/8 inch (9.5 mm)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hanover Architectural Products**]
b. <**Insert manufacturer's name**>

3. Thickness: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**]<**Insert dimension**>.
4. Face Size: [**4 by 6 inches (102 by 152 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (203 by 203 mm)**][**5 by 12 inches (127 by 305 mm)**][**6 by 12 inches (152 by 305 mm)**][**8-inch-(203-mm-) wide hexagon**]<**Insert dimensions**>.
5. Dimensional Tolerances: Plus or minus **1/16 inch (1.6 mm)**.
6. Finish: [**Natural, smooth**][**Ground**][**Ground and sandblasted**].
7. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

2.5 STONE PAVERS

A. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Granite Pavers: Rectangular paving slabs made from granite complying with ASTM C615/C615M.

1. Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**medium**][**fine**] grain.
2. Finish: [**Honed**][**Thermal**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
3. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
4. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**] unless otherwise indicated.
5. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

G. Limestone Pavers: Rectangular paving slabs made from limestone complying with ASTM C568/C568M.

1. Classification: [**II Medium-Density**][**III High-Density**].
2. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to

ASTM C241/C241M or ASTM C1353.

3. Indiana Oolitic Limestone Grade and Color: [**Select, buff**][**Select, gray**][**Standard, buff**][**Standard, gray**][**Rustic, buff**][**Rustic, gray**][**Variegated**], according to grade and color classification established by ILI.
4. Finish: [**Smooth**][**Chat sawed**][**Shot sawed**][**As indicated**]<**Insert finish**>.
5. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
6. Thickness: Not less than [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.
7. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

H. Marble Pavers: Rectangular paving slabs made from marble complying with ASTM C503/C503M.

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Description: Uniform, fine- to medium-grained, [**white**]<**Insert color**> stone with only slight veining.
3. Finish: [**Honed**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
4. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
5. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**] unless otherwise indicated.
6. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

I. Quartz-Based Stone Pavers: [**Rectangular paving slabs**][**Random polygonal flagstones**] made from quartz-based stone complying with ASTM C616/C616M, Classification [**I Sandstone**][**II Quartzitic Sandstone**][**III Quartzite**].

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Finish: [**Sand rubbed**][**Natural cleft**][**Thermal**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
3. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
4. Thickness: Not less than [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.
5. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**][**Random**]<**Insert dimensions**>.

J. Slate Pavers: [**Rectangular paving slabs**][**Random polygonal flagstones**] made from slate complying with ASTM C629/C629M, Classification I Exterior, with a fine, even grain[**and unfading color,**] from clear, sound stock.

1. Color: [**Black**][**Blue-black**][**Gray**][**Blue-gray**][**Green**][**Purple**][**Mottled purple and green**][**Red**].
2. Stone Abrasion Resistance: Minimum value of [**8**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
3. Finish: [**Honed**][**Sand rubbed**][**Natural cleft**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
4. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
5. Thickness: Not less than [**1/2 inch (13 mm)**][**3/4 inch (20 mm)**][**1 inch (25 mm)**] unless otherwise indicated.
6. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm)**

square][**9 by 18 inches (229 by 457 mm)**][**As indicated**][**Random**]<**Insert dimensions**>.

K. Travertine Pavers: Rectangular paving slabs made from travertine complying with ASTM C1527/C1527M, Classification I Exterior.

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Cut: Vein cut.
3. Filling: Fill pores on faces of stone with cementitious filler of color [**selected by Architect**][**matching Architect's sample**].
4. Finish: [**Honed**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
5. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
6. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**] unless otherwise indicated.
7. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

L. Rough Granite Pavers: Rectangular[**tumbled**] paving stones, with split[**or thermal-finished**] faces and edges, made from granite complying with ASTM C615/C615M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Buechel Stone Corp**]
    b. [**Cold Spring Granite Company**]
    c. [**Fletcher Granite Company**]
    d. [**Granicor**]
    e. [**Milestone Imports, Inc.**]
    f. [**North Carolina Granite Corporation**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Buechel Stone Corp**]
    b. [**Cold Spring Granite Company**]
    c. [**Fletcher Granite Company**]
    d. [**Granicor**]
    e. [**Milestone Imports, Inc.**]
    f. [**North Carolina Granite Corporation**]
    g. <**Insert manufacturer's name**>

3. Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**medium**][**fine**] grain.
4. Thickness: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**4 inches (102 mm), plus or minus 1/2 inch (13 mm)**]<**Insert dimension**>.
5. Face Size: [**4 by 4 inches (100 by 100 mm), plus or minus 1/2 inch (13 mm)**][**3 to 5 inches (75 to 125 mm) by 8 to 12 inches (200 to 300 mm)**][**As indicated**]<**Insert dimensions**>.

2.6 CURBS AND EDGE RESTRAINTS

A. Plastic Edge Restraints: Manufacturer's standard triangular PVC extrusions [**1-3/4 inches (45 mm) high by 3-1/2 inches (89 mm) wide**][**3-1/8 inches (79 mm) high by 9-1/2 inches (241 mm) wide**] designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges; with pipe connectors and **3/8-inch (9.5-mm)** diameter by **12-inch- (300-mm-)** long steel spikes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Brickstop Corporation**]
    b. [**Dimex LLC**]
    c. [**Oly-Ola Edgings, Inc.**]
    d. [**Pave Tech; Probst, Inc.**]
    e. [**Sure-loc Edging Corporation.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Brickstop Corporation**]
    b. [**Dimex LLC**]
    c. [**Oly-Ola Edgings, Inc.**]
    d. [**Pave Tech; Probst, Inc.**]
    e. [**Sure-loc Edging Corporation.**]
    f. <**Insert manufacturer's name**>

B. Steel Edge Restraints: Manufacturer's standard painted steel edging [**3/16 inch (4.8 mm) thick by 4 inches (100 mm) high**][**1/4 inch (6.4 mm) thick by 5 inches (125 mm) high**] with loops pressed from or welded to face to receive stakes at **36 inches (900 mm)** o.c. and steel stakes **15 inches (380 mm)** long for each loop.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Border Concepts, Inc**]
    b. [**COLMET**]
    c. [**J. D. Russell Company (The)**]
    d. [**Sure-loc Edging Corporation.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Border Concepts, Inc**]
    b. [**COLMET**]
    c. [**J. D. Russell Company (The)**]
    d. [**Sure-loc Edging Corporation.**]
    e. <**Insert manufacturer's name**>

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

C. Aluminum Edge Restraints: Manufacturer's standard [**straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high**][**straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high**][**L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high**][**L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high**] extruded-aluminum edging with loops pressed from face to receive stakes at **12 inches (300 mm)** o.c. and aluminum stakes **12 inches (300 mm)** long for each loop.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brickstop Corporation**]
   b. [**Curv-Rite, Inc**]
   c. [**Permaloc Corporation**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Brickstop Corporation**]
   b. [**Curv-Rite, Inc**]
   c. [**Permaloc Corporation**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

D. Job-Built Concrete Edge Restraints: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of **3000 psi (20 MPa)**.

E. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than [**5000 psi (34 MPa)**][**6000 psi (41 MPa)**]<**Insert value**> and water absorption not more than 5 percent, in shapes and sizes indicated.

1. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
2. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site.
3. Regional Materials: Concrete curbs shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
4. Indigenous Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
5. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

6. Color and Texture: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and texture**>.

F. Granite Curbs: Granite curbing, with face battered **1 inch per foot (1:12)**, produced in random lengths not less than **36 inches (900 mm)** from granite complying with ASTM C615/C615M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cold Spring Granite Company**]
    b. [**Fletcher Granite Company**]
    c. [**Granicor**]
    d. [**New England Stone, Inc.**]
    e. [**North Carolina Granite Corporation**]
    f. [**Polycor Inc.**]
    g. [**Swenson Granite Works; a Polycor Inc. company**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Cold Spring Granite Company**]
    b. [**Fletcher Granite Company**]
    c. [**Granicor**]
    d. [**New England Stone, Inc.**]
    e. [**North Carolina Granite Corporation**]
    f. [**Polycor Inc.**]
    g. [**Swenson Granite Works; a Polycor Inc. company**]
    h. <**Insert manufacturer's name**>

3. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
4. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.
5. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
6. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
8. Granite Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**fine**][**medium**][**coarse**] grain.
9. Top Width: [**4 inches (102 mm)**][**5 inches (127 mm)**][**6 inches (152 mm)**]<**Insert dimension**>.
10. Face Height: [**4 inches (102 mm)**][**6 inches (152 mm)**][**8 inches (203 mm)**]<**Insert dimension**>.
11. Total Height: [**12 inches (305 mm)**][**16 inches (406 mm)**][**18 inches (457 mm)**]<**Insert dimension**>.
12. Top Finish: [**Sawed**][**Thermal**][**Bush hammered**].

13. Face Finish: [**Split**][**Sawed**][**Thermal**][**Bush hammered**].

G. <**Insert requirements**>.

2.7 ACCESSORIES

A. Cork Joint Filler: Preformed strips complying with ASTM D1752, Type II.

B. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.8 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with [**ASTM D448 for Size No. 57**][**ASTM D2940/D2940M, subbase material**][**requirements in Section 312000 "Earth Moving" for subbase material**].

B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with [**ASTM D448 for Size No. 8**][**ASTM D2940/D2940M, base material**][**requirements in Section 312000 "Earth Moving" for base course**].

C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.

D. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D448 for Size No. 10.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing **No. 16 (1.18-mm)** sieve and no more than 10 percent passing **No. 200 (0.075-mm)** sieve.

1. Provide sand of color needed to produce required joint color.

F. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: **No. 60 (0.250-mm)** sieve, maximum; ASTM D4751.
3. Permittivity: 0.02 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

G. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: **No. 40 (0.425-mm)** sieve, maximum; ASTM D4751.
3. Permittivity: 0.5 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

H. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.9 BITUMINOUS SETTING-BED MATERIALS

A. Primer for Base: ASTM D2028/D2028M, cutback asphalt, grade as recommended by unit paver manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D1073, No. 2 or No. 3.

C. Asphalt Cement: ASTM D3381/D3381M, Viscosity Grade AC-10 or Grade AC-20.

D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing **No. 16 (1.18-mm)** sieve and no more than 10 percent passing **No. 200 (0.075-mm)** sieve.

1. Provide sand of color needed to produce required joint color.

2.10 MORTAR SETTING-BED MATERIALS

A. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Portland Cement: ASTM C150/C150M, Type I or Type II.

G. Hydrated Lime: ASTM C207, Type S.

H. Sand: ASTM C144.

I. Latex Additive: [**Manufacturer's standard**][**acrylic resin**][**or**][**styrene-butadiene-rubber**] water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

J. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Jamo Inc**]
   h. [**Laticrete International, Inc.**]
   i. [**MAPEI Corporation**]
   j. [**Parex, a Sika brand**]
   k. [**ProSpec; H.B. Fuller Construction Products Inc.**]
   l. [**Sakrete; CRH Americas, Oldcastle APG**]
   m. [**Southern Grouts & Mortars, Inc**]
   n. [**Summitville Tiles, Inc.**]
   o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Jamo Inc**]
   h. [**Laticrete International, Inc.**]
   i. [**MAPEI Corporation**]
   j. [**Parex, a Sika brand**]
   k. [**ProSpec; H.B. Fuller Construction Products Inc.**]
   l. [**Sakrete; CRH Americas, Oldcastle APG**]
   m. [**Southern Grouts & Mortars, Inc**]
   n. [**Summitville Tiles, Inc.**]
   o. <**Insert manufacturer's name**>

3. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
4. Provide prepackaged, dry-mortar mix combined with [**acrylic resin**][**or**][**styrene-butadiene-rubber**] liquid-latex additive at Project site.
5. Provide product that is approved by manufacturer for application thickness of [**5/8 inch (16 mm)**]<**Insert value**>.

K. Water: Potable.

L. Reinforcing Wire Fabric: Galvanized, welded wire fabric, **2 by 2 inches (50.8 by 50.8 mm)** by **0.062 inch (1.57 mm)** in diameter; comply with ASTM A1064/A1064M except for minimum wire size.

2.11 GROUT MATERIALS

A. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Sand-Portland Cement Grout: ANSI A108.10, made of white or gray cement and white or colored aggregate as required to produce color indicated.

1. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved, through testing and experience, to be satisfactory for use in portland cement grout.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Davis Colors**]
2) [**Lanxess Corporation**]
3) [**Solomon Colors Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Davis Colors**]
2) [**Lanxess Corporation**]
3) [**Solomon Colors Inc.**]
4) <**Insert manufacturer's name**>

G. Standard Cement Grout: ANSI A118.6, sanded.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
k. [**Sakrete; CRH Americas, Oldcastle APG**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
k. [**Sakrete; CRH Americas, Oldcastle APG**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]
n. <**Insert manufacturer's name**>

H. High-Performance Cement Grout: ANSI A118.7, sanded.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Jamo Inc**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]

m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Jamo Inc**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]
m. <**Insert manufacturer's name**>

3. Polymer Type:

a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
b. [**Acrylic resin**][**or**][**styrene-butadiene rubber**] in liquid-latex form for addition to prepackaged dry-grout mix.

I. Grout Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

J. Water: Potable.

2.12 BITUMINOUS SETTING-BED MIX

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to **300 deg F (149 deg C)**.

2.13 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Mortar-Bed Bond Coat: Mix neat cement and [**latex additive**][**water**] to a creamy consistency.

C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C270, Proportion Specification.

D. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

E. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.

F. Thinset Mortar Bond Coat: Proportion and mix according to manufacturer's written instructions.

G. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.

1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.
2. Colored-Aggregate Grout: Produce color required by combining colored aggregates with portland cement of selected color.

H. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected[**and waterproofing protection is in place**].

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive [**subbase**][**and**][**base**] course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where

possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: [**Running bond**][**Herringbone**][**Basket weave**][**Grid**][**As indicated**][**Match and continue existing unit paver joint pattern**].

F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

1. Provide joint filler at waterproofing that is turned up on vertical surfaces[**unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete**].

G. Tolerances:

1. Do not exceed **1/32-inch (0.8-mm)** unit-to-unit offset from flush (lippage) or **1/8 inch in 10 feet (3 mm in 3 m)** from level, or indicated slope, for finished surface of paving.
2. Do not exceed[**1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and**] **1/4 inch in 10 feet (6 mm in 3 m)** from level, or indicated slope, for finished surface of paving.

H. Expansion and Control Joints:

1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints[**unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete**]. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."
2. Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

I. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least **1 inch (25 mm)** below top edge.
3. Install job-built concrete edge restraints to comply with requirements in Section 033000 "Cast-in-Place Concrete."
4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

J. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.

1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.4 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least [**95**]<**Insert number**> percent of [**ASTM D698**][**ASTM D1557**] laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least **12 inches (300 mm)**.

D. Place aggregate[**subbase and**] base, compact by tamping with plate vibrator, and screed to depth indicated.

E. Place aggregate[**subbase and**] base, compact to 100 percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.

F. Place drainage geotextile over compacted base course, overlapping ends and edges at least **12 inches (300 mm)**.

G. Place leveling course and screed to a thickness of **1 to 1-1/2 inches (25 to 38 mm)**, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

H. Treat leveling course with herbicide to inhibit growth of grass and weeds.

I. Set pavers with a minimum joint width of **1/16 inch (1.5 mm)** and a maximum of **1/8 inch (3 mm)**, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed [**3/8 inch (10 mm)**]<**Insert dimension**> with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a **3500- to 5000-lbf (16- to 22-kN)** compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least **36 inches (900 mm)** of uncompacted pavers adjacent to temporary edges.
2. Before ending each day's work, compact installed concrete pavers except for **36-inch (900-mm)** width of uncompacted pavers adjacent to temporary edges (laying faces).
3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within **36 inches (90 mm)** of laying face.
4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

L. Do not allow traffic on installed pavers until sand has been vibrated into joints.

M. Repeat joint-filling process 30 days later.

3.5 BITUMINOUS SETTING-BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating **3/4-inch- (19-mm-)** deep control bars approximately **11 feet (3.3 m)** apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of **250 deg F (121 deg C)**. Strike setting bed smooth, firm, even, and not less than **3/4 inch (19 mm)** thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of **3/4 inch (19 mm)**. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to **185 deg F (85 deg C)**.

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of **1/16 inch (1.6 mm)**. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.6 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed **1/16-inch (1.6-mm)** thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately **1/2 inch (13 mm)**.

E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

G. Wet brick pavers before laying if the initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

H. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform **1/16-inch- (1.5-mm-)** thick bond coat to mortar bed or to back of each paver with a flat trowel.

I. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

J. Spaced Joint Widths: Provide [**3/8-inch (10-mm)**][**1/2-inch (13-mm)**][**3/4-inch (19-mm)**] nominal joint width with variations not exceeding plus or minus [**1/16 inch (1.5 mm)**][**1/8 inch (3 mm)**][**3/16 inch (4.5 mm)**].

K. Grouted Joints: Grout paver joints complying with ANSI A108.10.

L. Grout joints as soon as possible after initial set of setting bed.

1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.

M. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.7 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 32 14 00 00

SECTION 32 14 09 00 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.
8. Tree grates.
9. Tree-watering devices.

B. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 129200 "Interior Planters and Artificial Plants" for planters for live and artificial interior plants.
3. Section 328400 "Planting Irrigation" for complete irrigation systems.
4. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
5. Section 329600 "Transplanting" for transplanting non-nursery-grown trees.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.6 ACTION SUBMITTALS

A. Product Data:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.
8. Tree grates.
9. Tree-watering devices.

B. Product Data Submittals: For each product.

1. Plant Materials: Include quantities, sizes, quality, and verified sources for plant materials.

C. Samples for Verification: Actual sample of finished products for each of the following:

1. Organic Mulch: [**1-pint (0.5-L)**][**1-quart (1-L)**]<**Insert value**> volume of each organic mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.
2. Mineral Mulch: [**2 lb (1.0 kg)**][**5 lb (2.5 kg)**]<**Insert value**> of each mineral mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with source of mulch. Provide accurate indication of color, texture, and makeup.
3. Weed-Control Barrier: **12 by 12 inches (300 by 300 mm)**.
4. Proprietary Root-Ball-Stabilization Device: One unit.
5. Slow-Release, Tree-Watering Device: One unit of each size required.
6. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
7. Root Barrier: Width of panel by **12 inches (300 mm)**.

1.7 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: Percolation tests for tree pits. Include the following:

1. Tree identification number matching the plans.
2. Date of test.
3. Time when water was added to tree pit to start percolation test.
4. Time with photo documentation showing increments of testing with water level in tree pit.
5. Identification of tester.

B. Qualification Statements: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with manufacturer's certified analysis of standard products.

D. Pesticides and Herbicides: Product label and manufacturer's written application instructions specific to Project.

E. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: [**Three**][**Five**]<**Insert number**> years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certification: Installer's [**field supervisor**][**personnel assigned to the Work**] certified in [**one**][**all**] of the following categories from the National Association of Landscape Professionals:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Interior.
    c. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure in accordance with ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements **6 inches (150 mm)** above the root flare for trees up to **4-inch (100-mm)** caliper size, and **12 inches (300 mm)** above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials [**seven**]<**Insert number**> days in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, or walkways and pavements; or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Deliver bare-root stock plants within [**24 hours**][**36 hours**]<**Insert time**> of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball.

F. Store bulbs, corms, and tubers in a dry place at **60 to 65 deg F (16 to 18 deg C)** until planting.

G. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

H. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system

components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: <**Insert dates**>.
2. Fall Planting: <**Insert dates**>.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions in accordance with manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
b. Structural failures, including plantings falling or blowing over.
c. Faulty performance of [**tree stabilization**][**edgings**][**and**][**tree grates**]<**Insert item**>.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of [**planting completion**][**Substantial Completion**]<**Insert starting time**>.

a. Trees, Shrubs, Vines, and Ornamental Grasses: [**12**]<**Insert number**> months.
b. Ground Covers, Biennials, Perennials, and Other Plants: [**12**][**Nine**][**Six**][**Three**]<**Insert number**> months.
c. Annuals: [**Three**][**Two**]<**Insert number**> months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and

complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; with tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); with crossing trunks; with cut-off limbs more than **3/4 inch (19 mm)** in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare in accordance with ANSI Z60.1.

D. Labeling: Label [**each**][**at least one**] plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to ensure symmetry in planting.

F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery[**and that are in bud but are not yet in bloom**].

G. <**Insert requirements**>.

2.2 FERTILIZERS

A. Granular Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition:

a. [**0.75 lb/1000 sq. ft. (0.34 kg/92.9 sq. m),**)]3 percent of actual nitrogen, 4 percent phosphorous, and 3 percent potassium, by weight.
b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per **lb (0.45 kg)** of vesicular-arbuscular mycorrhizal fungi and 95 million spores per **lb (0.45 kg)** of ectomycorrhizal fungi, 33 percent hydrogel, and maximum of 5.5 percent inert material.

2.3 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, **3 oz./sq. yd. (101 g/sq. m)** minimum, composed of fibers inert to biological degradation and naturally resistant to chemicals, alkalis, and acids, formed into a stable network so that fibers retain their relative position.

B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, **4.8 oz./sq. yd. (162 g/sq. m)**.

2.4 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: [**Shredded hardwood**][**Ground or shredded bark**][**Wood and bark chips**][**Pine straw**][**Salt hay or threshed straw**][**Pine needles**][**Peanut, pecan, and cocoa-bean shells**]<**Insert type**>.
2. Size Range: [**3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum**]<**Insert dimensions**>.
3. Color: Natural.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a **1-inch (25-mm)** sieve; soluble-salt content of [**2 to 5**]<**Insert range or value**> dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: [**50 to 60**]<**Insert number range**> percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:

1. Type: [**Rounded riverbed gravel or smooth-faced stone**][**Crushed stone or gravel**][**Marble chips**][**Granite chips**]<**Insert type**>.
2. Size Range: [**1-1/2 inches (38 mm) maximum, 3/4 inch (19 mm) minimum**][**3/4 inch (19 mm) maximum, 1/4 inch (6.4 mm) minimum**]<**Insert dimensions**>.
3. Color: [**Uniform tan-beige color range acceptable to Architect**][**Readily available natural gravel color range**]<**Insert color**>.

2.5 HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.6 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new [**hardwood**][**softwood with specified wood pressure-preservative treatment**], free of knots, holes, cross grain, and other defects, **2-by-2-inch nominal (38-by-38-mm actual)** by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring **8 inches (200 mm)** in diameter and **48 inches (1200 mm)** long, treated with specified wood pressure-preservative treatment.
3. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or [**turnbuckles**][**compression springs**].
4. Guys and Tie Wires: ASTM A641/A641M, Class 1, galvanized-steel wire, two-strand, twisted, **0.106 inch (2.7 mm)** in diameter.
5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
6. Guy Cables: Five-strand, **3/16-inch- (4.8-mm-)** diameter, galvanized-steel cable, with zinc-coated [**turnbuckles**][**compression springs**], a minimum of **3 inches (75 mm)** long, with two **3/8-inch (10-mm)** galvanized eyebolts.
7. Flags: Standard surveyor's plastic flagging tape, white, **6 inches (150 mm)** long.
8. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and in accordance with manufacturer's written instructions.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Arborbrace**]
        2) [**Better Bilt Products, Inc.**]
        3) [**DeepRoot Green Infrastructure, LLC**]
        4) [**J. R. Partners**]
        5) [**MacLean Power Systems**]
        6) [**Villa Root Barrier; Villa Landscape Products**]
        7) <**Insert manufacturer's name**>

    b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

        1) [**Arborbrace**]
        2) [**Better Bilt Products, Inc.**]
        3) [**DeepRoot Green Infrastructure, LLC**]
        4) [**J. R. Partners**]
        5) [**MacLean Power Systems**]
        6) [**Villa Root Barrier; Villa Landscape Products**]
        7) <**Insert manufacturer's name**>

B. Root-Ball Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, **2-by-2-inch nominal (38-by-38-mm actual)** by length indicated; stakes pointed at one end.
2. Wood Screws: ASME B18.6.1.
3. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized in accordance with

manufacturer's written instructions unless otherwise indicated.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Border Concepts, Inc**]
2) [**MacLean Power Systems**]
3) [**Tree Staple, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Border Concepts, Inc**]
2) [**MacLean Power Systems**]
3) [**Tree Staple, Inc.**]
4) <**Insert manufacturer's name**>

C. Palm Bracing: Battens or blocks, struts, straps, and protective padding.

1. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, **2-by-4-inch nominal (38-by-89-mm actual)** by lengths indicated.
2. Straps: Adjustable steel or plastic package banding.
3. Padding: Burlap.
4. Proprietary Palm-Bracing Devices: Proprietary systems to secure each new planting by trunk; sized in accordance with manufacturer's written instructions unless otherwise indicated.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Arborbrace**]
2) [**Better Bilt Products, Inc.**]
3) [**Horticultural Consultants, Inc.**]
4) [**Villa Root Barrier; Villa Landscape Products**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Arborbrace**]
2) [**Better Bilt Products, Inc.**]
3) [**Horticultural Consultants, Inc.**]
4) [**Villa Root Barrier; Villa Landscape Products**]
5) <**Insert manufacturer's name**>

2.7 LANDSCAPE EDGINGS

A. Wood Edging: Of sizes indicated on Drawings, and wood stakes as follows:

1. Species: [**Western red cedar, all heart**][**Southern pine with specified wood pressure-preservative treatment**].
2. Stakes: Same species as edging, **1-by-2-inch nominal (19-by-38-mm actual)** by **18 inches (450 mm)** long, with galvanized nails for anchoring edging.

B. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Border Concepts, Inc**]
    b. [**COLMET**]
    c. [**J. D. Russell Company (The)**]
    d. [**Sure-loc Edging Corporation.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Border Concepts, Inc**]
    b. [**COLMET**]
    c. [**J. D. Russell Company (The)**]
    d. [**Sure-loc Edging Corporation.**]
    e. <**Insert manufacturer's name**>

3. Edging Size: [**3/16 inch (4.8 mm) thick by 4 inches (100 mm) deep**][**1/4 inch (6.4 mm) thick by 5 inches (125 mm) deep**][**1/4 inch (6.4 mm) thick by 4 inches (100 mm) deep**][**1/8 inch (3.2 mm) thick by 4 inches (100 mm) deep**][**1/8 inch (3.2 mm) thick by 6 inches (150 mm) deep**][**0.1 inch (2.5 mm) thick by 4 inches (100 mm) deep**]<**Insert dimensions**>.
4. Stakes: Tapered steel, a minimum of [**12 inches (300 mm)**][**15 inches (380 mm)**]<**Insert dimension**> long.
5. Accessories: Standard tapered ends, corners, and splicers.
6. Finish: [**Manufacturer's standard paint**][**Zinc coated**][**Unfinished**].

    a. Paint Color: [**Black**][**Green**][**Brown**].

C. Aluminum Edging: Standard-profile extruded-aluminum edging, **ASTM B221 (ASTM B221M)**, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Curv-Rite, Inc**]
    b. [**J. D. Russell Company (The)**]
    c. [**Permaloc Corporation**]
    d. [**Sure-loc Edging Corporation.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Curv-Rite, Inc**]
    b. [**J. D. Russell Company (The)**]
    c. [**Permaloc Corporation**]
    d. [**Sure-loc Edging Corporation.**]
    e. <**Insert manufacturer's name**>

3. Edging Size: [**3/16 inch (4.8 mm) thick by 5-1/2 inches (140 mm) deep**][**3/16 inch (4.8 mm) thick by 4 inches (100 mm) deep**][**1/8 inch (3.2 mm) thick by 5-1/2 inches (140 mm) deep**][**1/8 inch (3.2 mm) thick by 4 inches (100 mm) deep**]<**Insert dimensions**>.
4. Stakes: Aluminum, **ASTM B221 (ASTM B221M)**, Alloy 6061-T6, approximately **1-1/2 inches (38 mm)** wide by **12 inches (300 mm)** long.
5. Finish: [**Manufacturer's standard paint**][**Powder-coat paint**][**Mill (natural aluminum)**][**Black anodized**].

    a. Paint Color: [**Black**][**Green**][**Brown**].

D. Plastic Edging: Standard black polyethylene or vinyl edging, [**V-lipped bottom**][**horizontally grooved**]<**Insert configuration**>, extruded in standard lengths, with **9-inch (225-mm)** [**steel angle**][**plastic**] stakes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Oly-Ola Edgings, Inc.**]
    b. [**Permaloc Corporation**]
    c. [**Sure-loc Edging Corporation.**]
    d. [**Valley View Industries**]
    e. [**Villa Root Barrier; Villa Landscape Products**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Oly-Ola Edgings, Inc.**]
    b. [**Permaloc Corporation**]
    c. [**Sure-loc Edging Corporation.**]
    d. [**Valley View Industries**]
    e. [**Villa Root Barrier; Villa Landscape Products**]
    f. <**Insert manufacturer's name**>

3. Edging Size: [**0.1 inch (2.5 mm) thick by 5 inches (125 mm) deep**][**0.07 inch (1.8 mm) thick by 5 inches (125 mm) deep**]<**Insert dimensions**>.
4. Top Profile: [**Straight, with top 2 inches (50 mm) being 1/4 inch (6.4 mm) thick**][**Round top, 1/2 inch (13 mm) in diameter**][**Round top, 1 inch (25 mm) in diameter**].
5. Accessories: Manufacturer's standard alignment clips or plugs.

2.8 TREE GRATES

A. Tree Grates: Manufacturer's [**standard**][**custom designed**] tree grates[**and frames**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barry Pattern & Foundry Co., Inc**]
b. [**EJ Group, Inc.**]
c. [**Ironsmith Inc.**]
d. [**Neenah Foundry Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Barry Pattern & Foundry Co., Inc**]
b. [**EJ Group, Inc.**]
c. [**Ironsmith Inc.**]
d. [**Neenah Foundry Company**]
e. <**Insert manufacturer's name**>

3. Grates: ASTM A48/A48M, **Class 35 (Class 250)** or better, gray-iron castings.
4. Frames: [**ASTM A48/A48M, Class 35 (Class 250) or better, gray-iron castings**][**or**][**ASTM A36/A36M steel-angle, hot-dip galvanized,**] of shape, pattern, and size indicated.

B. Shape and Size: [**As indicated on Drawings**][**Round, 36 inches (914 mm) in diameter**][**Round, 72 inches (1828 mm) in diameter**][**48 inches (1219 mm) square**][**60 inches (1524 mm) square**][**Rectangular, 36 by 60 inches (914 by 1524 mm)**][**Rectangular, 48 by 72 inches (1219 by 1828 mm)**]<**Insert shape and dimensions**>.

C. Finish: [**As fabricated**][**Powder-coat finish**]<**Insert finish**>.

1. Color: Low-gloss [**black**][**dark brown**][**dark green**][**dark gray**]<**Insert color**>.

2.9 TREE-WATERING DEVICES

A. Watering Pipe: PVC pipe **4 inches (100 mm)** in diameter, site-cut to length as required, and with snug-fitting removable cap.

B. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over [**an extended time period**][**two to nine hours**][**two to three weeks**]<**Insert number or range**>; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BIO-PLEX**]

b. [**Engineered Watering Solutions; PQ Partners, LLC**]
c. [**Spectrum Products, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**BIO-PLEX**]
b. [**Engineered Watering Solutions; PQ Partners, LLC**]
c. [**Spectrum Products, Inc.**]
d. <**Insert manufacturer's name**>

3. Color: [**As selected by Architect from manufacturer's full range**][**black**][**dark chocolate**][**green**][**or**][**tan**]<**Insert color**>.

2.10 MISCELLANEOUS PRODUCTS

A. Root Barrier: Black, molded, modular panels [**18 inches (457 mm)**][**24 inches (610 mm)**]<**Insert dimension**> high (deep), **85 mils (2.2 mm)** thick, and with vertical root deflecting ribs protruding **3/4 inch (19 mm)** out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DeepRoot Green Infrastructure, LLC**]
b. [**NDS Inc**]
c. [**Villa Root Barrier; Villa Landscape Products**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**DeepRoot Green Infrastructure, LLC**]
b. [**NDS Inc**]
c. [**Villa Root Barrier; Villa Landscape Products**]
d. <**Insert manufacturer's name**>

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix in accordance with manufacturer's written instructions.

C. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with [**ASTM D448 for Size No. 8**]<**Insert requirements**>.

D. Planter Filter Fabric: [**Woven**][**Nonwoven**] geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until moisture content reaches acceptable levels to attain required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove soil and contamination as directed by Architect and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil in accordance with [**Section 329113 "Soil Preparation."**][**Section 329115 "Soil Preparation (Performance Specification)."**]

B. Placing Planting Soil: [**Place and mix planting soil in-place over exposed subgrade**][**Place manufactured planting soil over exposed subgrade**][**Blend planting soil in place**]<**Insert requirement**>.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate [**indicated on Drawings**][**in accordance with manufacturer's written instructions**]<**Insert application rate**>.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for [**balled and burlapped**][**balled and potted**][**container-grown**][**fabric bag-grown**] stock.
3. Excavate at least **12 inches (300 mm)** wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected [**overnight**][**after working hours**][**when unattended by Installer's personnel**].
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may[**not**] be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill **6-inch- (150-mm-)** diameter holes, **24 inches (600 mm)** apart, into free-draining strata or to depth of **10 ft. (3 m)**, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball in accordance with ANSI Z60.1. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare [**1 inch (25 mm) above**][**2 inches (50 mm) above**]<**Insert requirement**> adjacent finish grades.

1. Backfill: Planting soil .[**For trees, use excavated soil for backfill.**]
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap,

rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.

    a. Quantity: [**As indicated on Drawings**][**Two per plant**][**Three for each caliper inch of plant**]<**Insert requirement**>.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. [**Balled and Potted**][**and**][**Container-Grown**] Stock: Set each plant plumb and in center of planting pit or trench with root flare [**1 inch (25 mm) above**][**2 inches (50 mm) above**]<**Insert requirement**> adjacent finish grades.

1. Backfill: Planting soil .[**For trees, use excavated soil for backfill.**]
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare [**1 inch (25 mm) above**][**2 inches (50 mm) above**]<**Insert requirement**> adjacent finish grades.

1. Backfill: Planting soil .[**For trees, use excavated soil for backfill.**]
2. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare [**1 inch (25 mm) above**][**2 inches (50 mm) above**]<**Insert requirement**> adjacent finish grade.

1. Backfill: Planting soil .[**For trees, use excavated soil for backfill.**]
2. Spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole or touching the roots.
6. Continue backfilling process. Water again after placing and tamping final layer of soil.

G. Watering Pipe: During backfilling, install watering pipe **4 ft. (1.25 m)** deep into the planting pit outside the root ball [**as indicated on Drawings**][**and**][**with top of pipe 1 inch (25 mm) above the mulched**

surface].

H. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

A. Plant trees with approved mechanized tree spade at designated locations. Do not use tree spade to move trees larger than maximum size allowed for similar field-grown, balled-and-burlapped, root-ball diameter in accordance with ANSI Z60.1, or trees larger than manufacturer's maximum size recommendation for tree spade being used, whichever is smaller.

B. Use same tree spade to excavate the planting hole as will be used to extract and transport the tree.

C. When extracting tree, center the trunk within the tree spade and move tree with solid ball of earth.

D. Cut exposed roots cleanly during transplanting operations.

E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines in accordance with standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.8 INSTALLATION OF TREE-STABILIZATION MATERIALS

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying:

a. Stake trees of **2- through 5-inch (50- through 125-mm)** caliper. Stake trees of less than **2-inch (50-mm)** caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least **18 inches (450 mm)** below bottom of backfilled excavation and to extend [**to the dimension indicated on Drawings**][**at least 72 inches (1830 mm)**][**one-third of trunk height**]<**Insert dimension or requirement**> above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

b. Stake trees with two stakes for trees up to **12 ft. (3.6 m)** high and **2-1/2 inches (63 mm)** or less in caliper; three stakes for trees less than **14 ft. (4.2 m)** high and up to **4 inches (100 mm)** in caliper. Space stakes equally around trees.

2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than **14 ft. (4.2 m)** in height and more than **3 inches (75 mm)** in caliper unless otherwise indicated.

1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

    a. Securely attach guys to stakes **30 inches (760 mm)** long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide [**turnbuckle**][**compression spring**] for each guy wire and tighten securely.
    b. For trees more than [**6 inches (150 mm) in caliper**]<**Insert size**>, anchor guys to wood deadmen buried at least **36 inches (900 mm)** below grade. Provide [**turnbuckle**][**compression spring**] for each guy wire and tighten securely.
    c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to [**turnbuckle**][**compression spring**]. Allow enough slack to avoid rigid restraint of tree.
    d. Support trees with [**guy cable**][**or**][**multiple strands of tie wire**], connected to brass grommets of tree-tie webbing at contact points with tree trunk and reaching to [**turnbuckle**][**compression spring**]. Allow enough slack to avoid rigid restraint of tree.
    e. Attach flags to each guy wire, **30 inches (760 mm)** above finish grade.
    f. Paint [**turnbuckles**][**compression springs**] with luminescent white paint.

2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

C. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by root ball unless otherwise indicated.

1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of vertical stakes.

    a. Install stakes of length required to penetrate at least [**to dimension indicated on Drawings**][**18 inches (450 mm)**]<**Insert dimension**> below bottom of backfilled excavation. Saw stakes off at horizontal stake.
    b. Install screws through horizontal hold-down and penetrating at least **1 inch (25 mm)** into stakes. Predrill holes if necessary to prevent splitting wood.
    c. Install second set of stakes on other side of root trunk for larger trees.

2. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

D. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.

1. Site-Fabricated Palm-Bracing Method:

    a. Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact

trunk.

b. Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.

2. Proprietary Palm-Bracing Device: Install palm-bracing system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

3.9 INSTALLATION OF ROOT BARRIER

A. Install root barrier where trees are planted within [**60 inches (1500 mm)**][**48 inches (1200 mm)**]<**Insert dimension**> of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.

B. Align root barrier [**vertically**][**with bottom edge angled at 20 degrees away from the paving or other hardscape element**], and run it linearly along and adjacent to paving or other hardscape elements to be protected from invasive roots.

C. Install root barrier continuously for distance of [**60 inches (1500 mm)**]<**Insert dimension**> in each direction from tree trunk, for total distance of [**10 ft. (3 m)**]<**Insert dimension**> per tree. If trees are spaced closer, use single continuous piece of root barrier.

1. Position top of root barrier [**flush with finish grade**][**1/2 inch (13 mm) above finish grade**][**in accordance with manufacturer's written instructions**].
2. Overlap root barrier minimum of **12 inches (300 mm)** at joints.
3. Do not distort or bend root barrier during construction activities.
4. Do not install root barrier surrounding the root ball of tree.

3.10 PLACING SOIL IN PLANTERS

A. Place a layer of drainage gravel at least **4 inches (100 mm)** thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric [**4 inches (100 mm)**][**6 inches (150 mm)**]<**Insert dimension**> up on all sides. Duct tape along the entire top edge of filter fabric, to secure filter fabric against the sides during soil-filling process.

B. Fill planter with planting soil . Place soil in lightly compacted layers to elevation of **1-1/2 inches (38 mm)** below top of planter, allowing natural settlement.

3.11 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines [**9 inches (225 mm) apart**][**12 inches (300 mm) apart**][**18 inches (450 mm) apart**][**24 inches (600 mm) apart**][**as indicated on Drawings**] in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system

but to depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.12 INSTALLATION OF MULCHES

A. Install weed-control barriers before mulching in accordance with manufacturer's written instructions. Completely cover area to be mulched, overlapping edges minimum of [**6 inches (150 mm)**][**12 inches (300 mm)**], and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Treelike Shrubs in Turf Areas: Apply [**organic**][**mineral**] mulch ring of [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> average thickness, with [**12-inch (300-mm)**][**24-inch (600-mm)**][**36-inch (900-mm)**]<**Insert dimension**> radius around trunks or stems. Do not create a mulch cone or place mulch within [**3 inches (75 mm)**][**6 inches (150 mm)**]<**Insert distance**> of trunks or stems.
2. Organic Mulch in Planting Areas: Apply [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> average thickness of organic mulch [**extending 12 inches (300 mm) beyond edge of individual planting pit or trench**][**and**][**over whole surface of planting area**], and finish level with adjacent finish grades. Do not place mulch within [**3 inches (75 mm)**][**6 inches (150 mm)**]<**Insert distance**> of trunks or stems.
3. Mineral Mulch in Planting Areas: Apply [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> average thickness of mineral mulch [**extending 12 inches (300 mm) beyond edge of individual planting pit or trench**][**and**][**over whole surface of planting area**], and finish level with adjacent finish grades. Do not place mulch within [**3 inches (75 mm)**][**6 inches (150 mm)**]<**Insert distance**> of trunks or stems.

3.13 INSTALLATION OF LANDSCAPE EDGINGS

A. Wood Edging: Install wood edging where indicated.[**Mitre cut joints and connections at a 45-degree angle.**] Fasten each cut joint or connection with two galvanized nails. Anchor with wood stakes spaced up to **36 inches (900 mm)** apart, driven at least **1 inch (25 mm)** below top elevation of edging. Use two galvanized nails per stake to fasten edging, of length as needed to penetrate both edging and stake and provide **1/2-inch (13-mm)** clinch at point. Predrill stakes if needed to avoid splitting. Replace stakes that crack or split during installation process.

B. Steel Edging: Install steel edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately **30 inches (760 mm)** apart, driven below top elevation of edging.

C. Aluminum Edging: Install aluminum edging where indicated in accordance with manufacturer's written instructions. Anchor with aluminum stakes spaced approximately [**36 inches (900 mm)**][**48 inches (1200 mm)**] apart, driven below top elevation of edging.

D. Plastic Edging: Install plastic edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately [**36 inches (900 mm)**][**48 inches (1200**

mm)] apart, driven through upper base grooves or V-lip of edging.

E. Shovel-Cut Edging: Separate mulched areas from turf areas[**, curbs, and paving**] with 45-degree, **4- to 6-inch- (100- to 150-mm-)** deep, shovel-cut edge[**as indicated on Drawings**].

F. Mow-Strip Installation:

1. Excavate for mow strip[**as indicated on Drawings**].
2. Compact subgrade uniformly beneath mow strip.
3. Apply nonselective, pre-emergent herbicide that inhibits growth of grass and weeds.
4. Install [**wood**][**steel**][**aluminum**][**plastic**] edging, delineating the edge of mow strip.
5. Install weed-control barrier before mulching, covering area of mow strip, and overlapping and pinning edges of barrier at least **6 inches (150 mm)** and in accordance with manufacturer's written instructions.
6. Place indicated thickness of [**organic**][**mineral**] mulch, fully covering weed barrier.
7. Rake mulch to uniform surface level with adjacent finish grades.

3.14 INSTALLATION OF TREE GRATES

A. Tree Grates: Install in accordance with manufacturer's written instructions. Set grate segments flush with adjoining surfaces. Shim from supporting substrate with soil-resistant plastic. Maintain **3-inch- (75-mm-)** minimum growth radius around base of tree; break away portions of casting, if necessary, in accordance with manufacturer's written instructions.

3.15 INSTALLATION OF TREE-WATERING DEVICES

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water in accordance with manufacturer's written instructions.

3.16 APPLICATION OF HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written instructions. Do not apply to seeded areas.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.

C. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and in accordance with manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.17 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace

mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform tree pit percolation tests.
2. Tree pit construction will be considered defective if it does not pass percolation tests and inspections.
3. Do not proceed with planting in tree pits until satisfactory percolation is demonstrated.

C. Prepare test and inspection reports.

3.19 REPAIR AND REPLACEMENT

A. Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than [**25**]<**Insert number**> percent dead or in unhealthy condition[**before end of corrections period**] or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of [**6 inches (150 mm)**][**4 inches (100 mm)**]<**Insert dimension**> or smaller in caliper size.
2. Provide [**one**][**two**]<**Insert number**> new tree(s) of [**6-inch (150-mm)**][**4-inch (100-mm)**]<**Insert dimension**> caliper size for each tree being replaced that measures more than [**6 inches (150 mm)**][**4 inches (100 mm)**] in caliper size.
3. Species of Replacement Trees: [**Same species being replaced**][**Species selected by Architect**]<**Insert species**>.

3.20 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before [**Substantial Completion**]<**Insert time**>, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

END OF SECTION 32 14 09 00

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Task	Specification	Specification Description
32 14 09 00	32 14 00 00	Unit Paving
32 14 11 00	32 13 13 00	Concrete Paving
32 14 11 00	32 14 00 00	Unit Paving
32 14 13 00	32 14 00 00	Unit Paving
32 14 13 16	32 13 13 00	Concrete Paving
32 14 13 16	32 14 00 00	Unit Paving
32 14 13 19	32 13 13 00	Concrete Paving
32 14 13 19	32 14 00 00	Unit Paving

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SECTION 32 14 16 00 - VITRIFIED BRICK PAVEMENT REPLACEMENT

1.1 GENERAL

A. General
1. Limits of Brick Pavement Replacement shall be as per the detail entitled “Payment Limits for Surface Restoration” shown in the plans, plus one foot on each side. Alternate individual bricks may have to be removed in order to maintain staggered joint pattern along the edge of the undisturbed brick pavement.

1.2 PRODUCT

A. Preparation
1. Base shall be provided and shaped to match level, kind and thickness (4” min.) of adjoining base. The base material shall be compacted to meet the density standards. 4” 2500 PSI concrete base may be used for irregular patches and where compaction is otherwise impractical. Concrete shall be properly placed, consolidated and cured. One inch of sand, or good grade dirt, free from clay, loam or other foreign matter shall be used for cushion to hold the bricks in place. The sand shall be shaped to a true surface parallel to required finished pavement surface.

B. Materials
1. Existing bricks shall be cleaned, stored, and secured by the Contractor.

1.3 EXECUTION

A. Reinstallation of Bricks
1. The bricks shall be installed in rows, better face upward, sorted by size with joints staggered, then rolled daily with a static tandem wheel roller. Additional bricks, if required, will be supplied by the Owner. City Personnel shall inspect work daily. After inspection, the bricks shall be sprayed with a solution of lime and water, using 26 lbs. of lime to 55 gallons of water. Asphalt steep 7330 or equal shall be used for joint filler. The steep shall be heated until fluid and poured over bricks and removed when cool with square pointed shovels dipped in lime water. Removed asphalt may be reused. If adjoining bricks are grouted, new filler shall be grout (8:1, builders sand: cement).

B. Acceptance
1. Upon completion of the work, and before acceptance and final payment, the Contractor shall remove all false work, equipment, rubbish, surplus, and discarded materials. The Contractor shall restore in an acceptable manner all property, both public and private, damaged during the prosecution of the work. The Contractor shall leave the roadway in a neat and presentable condition each day.

END OF SECTION 32 14 16 00

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Task	Specification	Specification Description
32 14 16 00	32 13 13 00	Concrete Paving
32 14 16 00	32 14 00 00	Unit Paving
32 14 33 00	32 14 00 00	Unit Paving
32 14 33 13	32 14 00 00	Unit Paving
32 14 40 00	32 13 13 00	Concrete Paving
32 14 40 00	32 14 00 00	Unit Paving
32 16 13 13	32 13 13 00	Concrete Paving
32 16 13 14	32 13 13 00	Concrete Paving
32 16 13 16	32 13 13 00	Concrete Paving
32 16 13 19	32 13 13 00	Concrete Paving
32 16 13 23	32 13 13 00	Concrete Paving
32 16 13 33	32 13 13 00	Concrete Paving
32 16 13 43	32 13 13 00	Concrete Paving
32 16 23 00	32 13 13 00	Concrete Paving
32 16 23 00	32 14 00 00	Unit Paving

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SECTION 32 17 13 00 - PARKING BUMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete wheel stops.
2. Resilient wheel stops.
3. Resilient-shell, concrete-filled wheel stops.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Precast concrete wheel stops.
2. Resilient wheel stops.
3. Resilient-shell, concrete-filled wheel stops

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: For wheel stops, [**6 inches (150 mm) long**]<**Insert dimension**>, showing color and cross section; with mounting hardware.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Precast Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete; [**4000-psi (27.6-MPa)**]<**Insert value**> minimum compressive strength; [**manufacturer's standard height and width**][**4-1/2 inches (115 mm) high by 9 inches (225 mm) wide**]<**Insert dimensions**> by [**72 inches (1800 mm)**]<**Insert dimension**> long. Provide chamfered corners[**, transverse drainage slots on underside,**] and a minimum of [**two**][**three**] factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Eagle Precast, LLC**]
b. [**American Precast Concrete Inc.**]
c. [**Bush Concrete Products, Inc.**]

d. [**Cast-Crete USA, Inc.**]
e. [**Dura-Crete, Inc.**]
f. [**Granite Precasting and Concrete, Inc.**]
g. [**Oldcastle Infrastructure Inc.; CRH Americas**]
h. [**Steps Plus, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Eagle Precast, LLC**]
b. [**American Precast Concrete Inc.**]
c. [**Bush Concrete Products, Inc.**]
d. [**Cast-Crete USA, Inc.**]
e. [**Dura-Crete, Inc.**]
f. [**Granite Precasting and Concrete, Inc.**]
g. [**Oldcastle Infrastructure Inc.; CRH Americas**]
h. [**Steps Plus, Inc.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wheel stops from single source from single manufacturer.
4. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
5. Surface Sealer: [**Manufacturer's standard salt-resistant, clear sealer**]<**Insert requirement**>, applied at precasting location.
6. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch (13-mm) diameter, 14-inch (350-mm) minimum length**][**lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (203-mm) minimum length**][**hardware as standard with wheel-stop manufacturer**].

B. Resilient Wheel Stops: Solid, integrally colored [**rubber**][**or**][**plastic**]; UV stabilized; [**manufacturer's standard height and width**][**4 inches (100 mm) high by 6 inches (150 mm) wide**]<**Insert dimensions**> by [**72 inches (1800 mm)**]<**Insert dimension**> long. Provide chamfered corners and a minimum of [**two**][**three**][**four**] factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Checkers; Justrite Safety Group**]
b. [**GNR Technologies Inc.**]
c. [**Plastic Safety Systems, Inc.**]
d. [**Plasticade**]
e. [**RoadKare; a RubberForm company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Checkers; Justrite Safety Group**]
b. [**GNR Technologies Inc.**]
c. [**Plastic Safety Systems, Inc.**]

d. [**Plasticade**]
e. [**RoadKare; a RubberForm company**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wheel stops from single source from single manufacturer.
4. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
5. Color: [**Black**][**Yellow**][**Gray**][**Green**][**Blue**]<**Insert color**>.
6. Embedded Markings: Molded-in, [**blue**][**white**][**yellow**] reflective markings, permanently inset in exposed surface.
7. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch (13-mm) minimum diameter, 14-inch (350-mm) minimum length**][**lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (203-mm) minimum length**][**hardware as standard with wheel-stop manufacturer**].
8. Adhesive: Polyurethane or epoxy, as recommended in writing by wheel-stop manufacturer for adhesion to substrate.

C. Resilient-Shell, Concrete-Filled Wheel Stops: Integrally colored HDPE polymer; UV-stabilized resilient shell; filled with precast, steel-reinforced concrete; [**4000-psi (27.6-MPa)**]<**Insert value**> minimum compressive strength; [**manufacturer's standard height and width**][**5 inches (125 mm) high by 6 inches (150 mm) wide**]<**Insert dimensions**> by [**72 inches (1800 mm)**]<**Insert dimension**> long. Provide chamfered corners and a minimum of [**two**][**three**] factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Century Group Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Century Group Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wheel stops from single source from single manufacturer.
4. Color: [**Yellow**][**Blue**]<**Insert color**>.
5. Surface Appearance: Smooth and uniform, with straight and sharp corners.
6. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch (13-mm) minimum diameter, 14-inch (350-mm) minimum length**][**hardware as standard with wheel-stop manufacturer**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wheel stops in accordance with manufacturer's written instructions unless otherwise indicated.

B. Install wheel stops in bed of adhesive before anchoring to substrate.

C. Securely anchor wheel stops to substrate with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION 32 17 13 00

Task	Specification	Specification Description
32 17 13 16	32 17 13 00	Parking Bumpers
32 17 13 19	32 17 13 00	Parking Bumpers
32 17 13 23	11 12 00 00	Parking Control Equipment
32 17 13 23	13 34 23 16	Fabricated Control Booths
32 17 13 23	32 17 13 00	Parking Bumpers
32 17 13 26	11 12 00 00	Parking Control Equipment
32 17 13 26	13 34 23 16	Fabricated Control Booths
32 17 13 26	32 17 13 00	Parking Bumpers

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SECTION 32 17 16 00 - MANUFACTURED TRAFFIC-CALMING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Speed bumps.
2. Speed humps.
3. Speed cushions.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Speed bumps.
2. Speed humps.
3. Speed cushions.

B. Sustainable Design Submittals:

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: Manufactured traffic-calming devices, [**6 inches long**]<**Insert dimension**>, showing color and cross section; with fasteners.

PART 2 - PRODUCTS

2.1 SPEED BUMPS

A. Speed Bumps: Solid, integrally colored, preformed [**recycled rubber**][**or**][**polyurethane**]; UV stabilized. Provide factory-formed or -drilled vertical holes for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barco Products Company**]
b. [**Checkers; Justrite Safety Group**]
c. [**Pawling Corporation**]
d. [**Plasticade**]
e. [**RoadKare; a RubberForm company**]
f. [**RubberForm Recycled Products, LLC**]
g. [**Traffic Logix**]
h. <**Insert manufacturer's name**>

2. Source Limitations: Obtain speed bumps from single source from single manufacturer.

3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
4. Size: [**2 inches high by 10 inches wide by 72 inches long**]<**Insert dimensions**>; with tapered, square, or rounded ends.
5. Color: [**Black**][**Yellow**]<**Insert color**>.
6. Embedded Markings: Molded-in, [**blue**][**white**][**yellow**] reflective markings, permanently inset in exposed surface.
7. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch diameter, 10-inch minimum length**][**lag screw, shield, and washers; 1/2-inch diameter, 8-inch minimum length**][**hardware as standard with speed bump manufacturer**].
8. Adhesive: [**As recommended in writing by speed bump manufacturer**]<**Insert requirement**> to permanently adhere speed bump to substrate.

2.2 SPEED HUMPS

A. Speed Humps: Solid, integrally colored, preformed recycled rubber; UV stabilized. Provide factory-formed or -drilled vertical holes for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Barco Products Company**]
    b. [**Checkers; Justrite Safety Group**]
    c. [**Plasticade**]
    d. [**RoadKare; a RubberForm company**]
    e. [**RubberForm Recycled Products, LLC**]
    f. [**Traffic Logix**]
    g. <**Insert manufacturer's name**>

2. Source Limitations: Obtain speed humps from single source from single manufacturer.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
4. Size: Modular assembly [**3 inches high by 12 feet in overall width**][**4 inches high by 14 feet in overall width**]<**Insert dimensions**>, with overall length as dimensioned on Drawings; and with tapered, square, or rounded ends.
5. Surface Profile: [**Circular**][**Sinusoidal**][**Trapezoidal**].
6. Color: [**Black**][**Yellow**]<**Insert color**>.
7. Embedded Markings: Molded-in, [**blue**][**white**][**yellow**] reflective markings, permanently inset in exposed surface.
8. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch diameter, 10-inch minimum length**][**lag screw, shield, and washers; 1/2-inch diameter, 8-inch minimum length**][**hardware as standard with speed hump manufacturer**].
9. Adhesive: [**As recommended in writing by speed hump manufacturer**]<**Insert requirement**> to permanently adhere speed hump to substrate.

2.3 SPEED CUSHIONS

A. Speed Cushions: Solid, integrally colored, preformed recycled rubber; UV stabilized. Provide factory-formed or -drilled vertical holes for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Barco Products Company**]
b. [**RoadKare; a RubberForm company**]
c. [**RubberForm Recycled Products, LLC**]
d. [**Traffic Logix**]
e. <**Insert manufacturer's name**>

2. Source Limitations: Obtain speed cushions from single source from single manufacturer.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
4. Size: Modular assembly [**3 inches high by 12 feet in overall width**][**4 inches high by 14 feet in overall width**]<**Insert dimensions**>, with overall length as dimensioned on Drawings; and with tapered, square, or rounded ends.
5. Color: [**Black**][**Yellow**]<**Insert color**>.
6. Embedded Markings: Molded-in, [**blue**][**white**][**yellow**] reflective markings, permanently inset in exposed surface.
7. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch diameter, 10-inch minimum length**][**lag screw, shield, and washers; 1/2-inch diameter, 8-inch minimum length**][**hardware as standard with speed cushion manufacturer**].
8. Adhesive: [**As recommended in writing by speed cushion manufacturer**]<**Insert requirement**> to permanently adhere speed cushions to substrate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install manufactured traffic-calming devices according to manufacturer's written instructions unless otherwise indicated.

B. Install devices in bed of adhesive before anchoring.

C. Securely anchor devices to substrate with hardware spaced as recommended in writing by manufacturer for heavy traffic. Recess head of hardware beneath top surface of device.

END OF SECTION 32 17 16 00

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Task	Specification	Specification Description
32 17 16 00	32 12 16 00	Asphalt Paving

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SECTION 32 17 23 00 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Painted markings applied to asphalt paving.
2. Painted markings applied to concrete surfaces.

B. Related Requirements:

1. Section 071800 "Traffic Coatings" for painting whole areas of building floors and pavements with coatings having an integral wearing surface.
2. Section 099113 "Exterior Painting" for painting exterior concrete surfaces other than pavement markings.
3. Section 099123 "Interior Painting" for painting interior concrete surfaces other than pavement markings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to marking asphalt paving or concrete surfaces including, but not limited to, the following:

a. Asphalt-paving or concrete-surface aging period before application of pavement markings.
b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.3 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Pavement-marking paint, alkyd.
2. Pavement-marking paint, solvent-borne.
3. Pavement-marking paint, acrylic.
4. Pavement-marking paint, latex.
5. Glass beads.

B. Shop Drawings:

1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Samples: For each exposed product and for each color and texture specified; on rigid backing, **8 inches (200 mm)** square.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of <**Insert applicable standards**> of <**Insert name of state or local DOT**> for pavement-marking work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of [**40 deg F (4.4 deg C) for alkyd materials**][**55 deg F (12.8 deg C) for water-based materials**], and not exceeding **95 deg F (35 deg C)**.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**]<**Insert requirement**>.

2.2 PAVEMENT-MARKING PAINT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aexcel Corporation**]
2. [**Colorado Paint Company II, LLC; SWARCO America, Inc.**]
3. [**Columbia Paint & Coatings, Inc.; a subsidiary of Sherwin-Williams Company (The)**]
4. [**Conco Paints**]
5. [**Diamond Vogel Paint Company**]
6. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
7. [**Ennis-Flint, Inc.**]
8. [**Farrell-Calhoun**]
9. [**Florida Paints**]
10. [**General Paint**]
11. [**Insl-X Products; Benjamin Moore & Co.**]
12. [**McCormick Paints**]
13. [**PPG Paints; PPG Industries, Inc.**]
14. [**Rodda Paint Co.**]
15. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
16. [**Sherwin-Williams Company (The)**]
17. [**The Dow Chemical Company**]
18. [**Transpo Industries, Inc.**]
19. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aexcel Corporation**]
2. [**Colorado Paint Company II, LLC; SWARCO America, Inc.**]
3. [**Columbia Paint & Coatings, Inc.; a subsidiary of Sherwin-Williams Company (The)**]
4. [**Conco Paints**]
5. [**Diamond Vogel Paint Company**]
6. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
7. [**Ennis-Flint, Inc.**]
8. [**Farrell-Calhoun**]
9. [**Florida Paints**]
10. [**General Paint**]
11. [**Insl-X Products; Benjamin Moore & Co.**]
12. [**McCormick Paints**]
13. [**PPG Paints; PPG Industries, Inc.**]
14. [**Rodda Paint Co.**]
15. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
16. [**Sherwin-Williams Company (The)**]
17. [**The Dow Chemical Company**]
18. [**Transpo Industries, Inc.**]
19. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pavement-marking paints from single source from single manufacturer.

D. Pavement-Marking Paint, Alkyd: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, [**Type N**][**Type F**][**Type S**]; colors complying with FS TT-P-1952F.

1. Color: [**White**][**Yellow**][**Blue**][**As indicated**]<**Insert color**>.

E. Pavement-Marking Paint, Solvent-Borne: MPI #32, solvent-borne traffic-marking paint.

1. Color: [**White**][**Yellow**][**Blue**][**As indicated**]<**Insert color**>.

F. Pavement-Marking Paint, Acrylic: Acrylic, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952F, Type II, with drying time of less than [**three**][**45**] minutes.

1. Color: [**White**][**Yellow**][**Blue**][**As indicated**]<**Insert color**>.

G. Pavement-Marking Paint, Latex: MPI #97, latex traffic-marking paint.

1. Color: [**White**][**Yellow**][**Blue**][**As indicated**]<**Insert color**>.

H. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325D, Type 1[**, made of 100 percent recycled glass**].

1. Roundness: Minimum [**75**][**80**] percent true spheres by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow asphalt paving or concrete surfaces to age for a minimum of [**30**][**90**]<**Insert number**> days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of [**15 mils (0.4 mm)**]<**Insert dimension**>.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
2. Broadcast glass beads uniformly into wet markings at a rate of **6 lb/gal. (0.72 kg/L)**.

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 32 17 23 00

Task	Specification	Specification Description
32 17 23 13	07 18 00 00	Traffic Coatings
32 17 23 13	32 12 16 00	Asphalt Paving
32 17 23 13	32 13 13 00	Concrete Paving
32 17 23 13	32 17 23 00	Pavement Markings
32 17 23 23	07 18 00 00	Traffic Coatings
32 17 23 23	32 12 16 00	Asphalt Paving
32 17 23 23	32 13 13 00	Concrete Paving
32 17 23 23	32 17 23 00	Pavement Markings
32 17 23 33	07 18 00 00	Traffic Coatings
32 17 23 33	32 12 16 00	Asphalt Paving
32 17 23 33	32 13 13 00	Concrete Paving
32 17 23 33	32 17 23 00	Pavement Markings

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SECTION 32 17 26 00 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.
2. Surface-applied detectable warning tiles.
3. Detectable warning mats.
4. Cast-in-place detectable warning metal tiles.
5. Surface-applied detectable warning metal tiles.
6. Detectable warning unit pavers.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.
2. Section 321400 "Unit Paving" for unit paving installations incorporating detectable warning unit pavers specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: For each type of tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Adhesive Application:

1. Apply adhesive only when ambient temperature is above **50 deg F (10 deg C)** and when temperature has not been below **35 deg F (2 deg C)** for 12 hours immediately before application. Do not apply when substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of **100 deg F (38 deg C)** and higher.

a. When ambient temperature exceeds **100 deg F (38 deg C)**, or when wind velocity exceeds **8 mph (13 km/h)** and ambient temperature exceeds **90 deg F (32 deg C)**, set unit pavers within 1 minute of spreading setting-bed mortar.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering and wear.
b. Separation or delamination of materials and components.

2. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in [**the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities**][**and**][**ICC A117.1**] for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Source Limitations: Obtain each type of tactile warning surfacing[**, joint material**][**, setting material**][**, anchor**][**, and**][**fastener**] from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles[**with replaceable surface**] configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACO Polymer Products, Inc.**]

b. [**ADA Solutions, a division of SureWerx USA**]
c. [**Arcis Corp.**]
d. [**Armor-Tile**]
e. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
f. [**Detectable Warning Systems, Inc.**]
g. [**Detectile Corp.**]
h. [**Ecoglo, Inc.**]
i. [**Mingo Products, Inc.**]
j. [**StrongGo Industries, LLC**]
k. [**Transpo Industries, Inc.**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACO Polymer Products, Inc.**]
b. [**ADA Solutions, a division of SureWerx USA**]
c. [**Arcis Corp.**]
d. [**Armor-Tile**]
e. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
f. [**Detectable Warning Systems, Inc.**]
g. [**Detectile Corp.**]
h. [**Ecoglo, Inc.**]
i. [**Mingo Products, Inc.**]
j. [**StrongGo Industries, LLC**]
k. [**Transpo Industries, Inc.**]
l. <**Insert manufacturer's name**>

3. Material: [**Cast-fiber-reinforced polymer concrete tile**][**Molded glass- and carbon-fiber-reinforced polyester**].
4. Color: [**Safety yellow**][**Red brick**][**Black**][**Gray**][**As selected by Architect from manufacturer's full line**].
5. Shapes and Sizes:

a. Rectangular panel, [**12 by 12 inches (305 by 305 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**][**36 by 48 inches (914 by 1219 mm)**][**36 by 60 inches (914 by 1524 mm)**]<**Insert dimensions**>.
b. Radius panel, nominal **24 inches (610 mm)** deep by [**6-foot (1829-mm)**][**8-foot (2438-mm)**][**10-foot (3048-mm)**][**12-foot (3658-mm)**][**15-foot (4572-mm)**]<**Insert dimension**> outside radius.

6. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
7. Mounting:

a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.
b. Detectable warning tile set into formed recess in concrete and adhered with [**mortar**][**adhesive**].
c. Replaceable detectable warning tile wet-set into freshly poured concrete and surface-fastened to permanently embedded anchors.

B. Surface-Applied Detectable Warning Tiles: Accessible truncated-dome detectable warning concrete tiles configured for surface application on existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of tile, and beveled outside edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ADA Solutions, a division of SureWerx USA**]
   b. [**Arcis Corp.**]
   c. [**Armor-Tile**]
   d. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   e. [**Detectable Warning Systems, Inc.**]
   f. [**Ecoglo, Inc.**]
   g. [**Transpo Industries, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ADA Solutions, a division of SureWerx USA**]
   b. [**Arcis Corp.**]
   c. [**Armor-Tile**]
   d. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   e. [**Detectable Warning Systems, Inc.**]
   f. [**Ecoglo, Inc.**]
   g. [**Transpo Industries, Inc.**]
   h. <**Insert manufacturer's name**>

3. Material: [**Cast-fiber-reinforced polymer concrete tile**][**Molded glass- and carbon-fiber-reinforced polyester**].
4. Color: [**Safety yellow**][**Red brick**][**Black**][**Gray**][**As selected by Architect from manufacturer's full line**].
5. Shapes and Sizes:

   a. Rectangular panel, [**12 by 12 inches (305 by 305 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**][**36 by 48 inches (914 by 1219 mm)**][**36 by 60 inches (914 by 1524 mm)**]<**Insert dimensions**>.
   b. Radius panel, nominal **24 inches (610 mm)** deep by [**6-foot (1829-mm)**][**8-foot (2438-mm)**][**10-foot (3048-mm)**][**12-foot (3658-mm)**][**15-foot (4572-mm)**]<**Insert dimension**> outside radius.

6. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
7. Mounting: Adhered[**and fastened**] to existing concrete walkway.

C. Cast-in-Place Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles[**with replaceable surface**] configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ADA Solutions, a division of SureWerx USA**]
    b. [**Advantage Tactile Systems**]
    c. [**EJ Group, Inc.**]
    d. [**Neenah Foundry Company**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ADA Solutions, a division of SureWerx USA**]
    b. [**Advantage Tactile Systems**]
    c. [**EJ Group, Inc.**]
    d. [**Neenah Foundry Company**]
    e. <**Insert manufacturer's name**>

3. Material:

    a. Stainless-Steel Plate and Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**].

        1) Finish and Color:

            a) Manufacturer's standard powder coat, [**safety yellow**][**red brick**][**black**][**gray**][**color as selected by Architect from manufacturer's full line**].
            b) Mill finish.

    b. Cast Iron: Gray iron, ASTM A48/A48M, CL 35.

4. Shapes and Sizes:

    a. Rectangular panel, [**12 by 12 inches (305 by 305 mm)**][**18 by 24 inches (457 by 610 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**][**36 by 48 inches (914 by 1219 mm)**][**36 by 60 inches (914 by 1524 mm)**]<**Insert dimensions**>.
    b. Radius panel, nominal **24 inches (610 mm)** deep by [**6-foot (1829-mm)outside radius**][**8-foot (2438-mm)outside radius**][**10-foot (3048-mm)outside radius**][**12-foot (3658-mm)outside radius**][**15-foot (4572-mm) outside radius**][**17.5-foot (5334-mm)outside radius**][**outside radius indicated on Drawings**]<**Insert dimension**>.

5. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
6. Mounting:

    a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.
    b. Permanently embedded detectable warning tile set into formed recess in concrete and adhered with [**mortar**][**adhesive**].
    c. Replaceable embedded detectable warning tile fastened to permanently installed anchors.

D. Surface-Applied Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles or plates configured for fastening to surface of existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of tile, and beveled outside edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advantage Tactile Systems**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advantage Tactile Systems**]
   b. <**Insert manufacturer's name**>

3. Material: Stainless-Steel Plate and Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**].
4. Finish and Color:

   a. Manufacturer's standard powder coat, [**safety yellow**][**red brick**][**black**][**gray**][**color as selected by Architect from manufacturer's full line**].
   b. Mill finish.

5. Shapes and Sizes:

   a. Rectangular panel, [**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**]<**Insert dimensions**>.

6. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
7. Mounting:

   a. Replaceable surface-applied detectable warning tile fastened with permanently installed anchors to existing concrete walkway.
   b. Permanently fixed detectable warning tile adhered[**and fastened**] to existing concrete walkway.

2.3 DETECTABLE WARNING MATS

A. Surface-Applied Detectable Warning Mats: Accessible truncated-dome detectable warning resilient mats, UV resistant, manufactured for adhering to existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of mat, and beveled outside edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Detectable Warning Systems, Inc.**]

b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. **[Detectable Warning Systems, Inc.]**
   b. **<Insert manufacturer's name>**

3. Material: Modified rubber compound, UV resistant.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.
5. Shapes and Sizes:

   a. Rectangular panel, [**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**]<**Insert dimensions**>.

6. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
7. Mounting: Adhered to pavement surface with adhesive[**and fastened with fasteners**].

2.4 DETECTABLE WARNING UNIT PAVERS

A. Detectable Warning Concrete Unit Pavers: Solid paving units, made from normal-weight concrete with a compressive strength of not less than **5000 psi (34 MPa)** **<Insert value>**, water absorption of not more than 5 percent according to ASTM C140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67, with accessible detectable warning truncated domes on exposed surface of units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. **[Advanced Surfaces Inc.]**
   b. **[Armor-Tile]**
   c. **[ECG, Inc.; a division of Elizabeth City Glass Co.]**
   d. **[Hanover Architectural Products]**
   e. **[Tile Tech Pavers]**
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. **[Advanced Surfaces Inc.]**
   b. **[Armor-Tile]**
   c. **[ECG, Inc.; a division of Elizabeth City Glass Co.]**
   d. **[Hanover Architectural Products]**
   e. **[Tile Tech Pavers]**
   f. **<Insert manufacturer's name>**

3. Shapes and Sizes:

a. Thickness: [2 inches (51 mm)][2-1/2 inches (63 mm)]<**Insert dimension**> at field of tile.
b. Face Size: Nominal [12 by 12 inches (305 by 305 mm)][24 by 24 inches (610 by 610 mm)]<**Insert dimensions**>.

4. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
5. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

B. Setting Bed: Comply with requirements in Section 321400 "Unit Paving."

C. Aggregate Setting Bed:

1. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D448 for Size No. 8.
2. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
3. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing **No. 16 (1.18-mm)** sieve and no more than 10 percent passing **No. 200 (0.075-mm)** sieve.

D. Mortar Setting Bed:

1. Portland Cement: ASTM C150/C150M, Type I or Type II.
2. Sand: ASTM C33/C33M.
3. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
4. Thinset Mortar: Latex-modified portland cement mortar complying with ANSI A118.4.
5. Water: Potable.

2.5 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish [**Type 304**][**Type 316**] stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.
2. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus **1/8 inch (3 mm)** from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

B. Removable Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of removable tile.
2. Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus **1/8 inch (3 mm)** from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

C. Surface-Applied Detectable Warning Tiles:

1. Lay out detectable warning tiles as indicated and mark concrete pavement.
2. Prepare existing paving surface by grinding and cleaning as recommended by manufacturer.

    a. Cut perimeter kerf in existing concrete pavement to receive metal tile flange.

3. Apply adhesive to back of tiles in amounts and pattern recommended by manufacturer, and set tiles in place. Firmly seat tiles in adhesive bed, eliminating air pockets and establishing full adhesion to pavement. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
4. Install anchor devices through face of tiles and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with top surface of mat.

5. Mask perimeter of tiles and adjacent concrete, and apply sealant in continuous bead around perimeter of tile installation.
6. Remove masking, adhesive, excess sealant, and soil from exposed surfaces of detectable warning tiles and surrounding concrete pavement using cleaning agents recommended in writing by manufacturer.
7. Protect installed tiles from traffic until adhesive has set.

3.4 INSTALLATION OF DETECTABLE WARNING MATS

A. Lay out detectable warning mats as indicated and mark concrete pavement at edges of mats.

B. Prepare existing paving surface by grinding and cleaning as recommended by manufacturer.

C. Apply adhesive to back of mat in amounts and pattern recommended by manufacturer, and set mat in place. Firmly seat mat in adhesive bed, eliminating air pockets and establishing full adhesion to pavement. If necessary, temporarily apply weight to mat to ensure full contact with adhesive.

D. Install anchor devices through face of mat and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with mat surface.

E. Mask mat perimeter and adjacent concrete, and apply sealant in continuous bead around perimeter of mat.

F. Remove masking, adhesive, excess sealant, and soil from exposed surfaces of detectable warning mat and surrounding concrete pavement using cleaning agents recommended in writing by manufacturer.

G. Protect installed mat from traffic until adhesive has set.

3.5 INSTALLATION OF DETECTABLE WARNING UNIT PAVERS

A. Unit Paver Installation, General:

1. Setting-Bed and Unit Paver Installation: Comply with installation requirements in Section 321400 "Unit Paving."
2. Mix unit pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
3. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
4. Tolerances: Do not exceed **1/4 inch in 10 feet (6 mm in 3 m)** from level, or indicated slope, for finished surface of paving.

B. Aggregate Setting-Bed Applications:

1. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.
2. Place leveling course and screed to a thickness of **1 to 1-1/2 inches (25 to 38 mm)**, taking care that moisture content remains constant and density is loose and uniform until unit pavers are set and compacted.
3. Treat leveling course with herbicide to inhibit growth of grass and weeds.
4. Set unit pavers with a minimum joint width of **1/16 inch (1.5 mm)** and a maximum of **1/8 inch (3 mm)**, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines.
5. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a **3500- to 5000-lbf (16- to 22-kN)** compaction force at 80 to 90 Hz.
6. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate

pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

C. Mortar Setting-Bed Applications:

1. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed **1/16-inch (1.6-mm)** thickness for bond coat.
3. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
4. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
5. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform **1/16-inch- (1.5-mm-)** thick bond coat to mortar bed or to back of each paver with a flat trowel.
6. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
7. Spaced Joint Widths: Provide [**3/8-inch (10-mm)**][**1/2-inch (13-mm)**] nominal joint width with variations not exceeding plus or minus [**1/16 inch (1.5 mm)**][**1/8 inch (3 mm)**].
8. Grouted Joints: Grout paver joints complying with ANSI A108.10. Grout joints as soon as possible after initial set of setting bed.

    a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
    b. Tool exposed joints slightly concave when thumbprint hard.
    c. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

9. Remove excess grout from exposed paver surfaces; wash and scrub clean.
10. Protect installation from traffic until grout has set.

3.6 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 32 17 26 00

Task	Specification	Specification Description
32 32 16 00	03 41 00 00	Precast Structural Concrete

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SECTION 32 32 23 00 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Segmental retaining walls.

B. Related Requirements:

1. Section 312000 "Earth Moving" for excavation for segmental retaining walls, base material, soil fill, fill placement and compaction, and field in-place density testing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show sizes, profiles, coursing, and locations of retaining wall units; including backfill and leveling base materials.
2. Show types, sizes, locations of soil reinforcing materials.
3. <**Insert requirements**>.
4. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and textures for segmental retaining wall units.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish of segmental retaining wall units.

1. Size: [**Manufacturers' standard size**][**full-size units**][**sections of units not less than 3 inches (75 mm) square**]<**Insert size**>.

E. Delegated Design Submittals: For segmental retaining walls, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and

point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Certificates: For each type of segmental retaining wall unit[**and soil reinforcement**] from manufacturer.

1. Include test data for shear strength between segmental retaining wall units in accordance with ASTM D6916.
2. Include test data for connection strength between segmental retaining wall units and soil reinforcement in accordance with ASTM D6638.

C. Test and Evaluation Reports:

1. Product Test Reports: For each type of segmental retaining wall unit[**and soil reinforcement**], for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

a. Include test data for shear strength between segmental retaining wall units in accordance with ASTM D6916.
b. Include test data for connection strength between segmental retaining wall units and soil reinforcement in accordance with ASTM D6638.

2. Research Reports: For segmental retaining wall system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**]<**Insert evaluation agency**> showing compliance with [**building code requirements**]<**Insert requirement**>.
3. Preconstruction Test Reports: For segmental retaining wall units[**and soil reinforcement**].

D. Source Quality-Control Submittals:

1. Source quality-control reports.

E. Field Quality-Control Submittals:

1. Field quality-control reports.

F. Qualification Statements: For [**testing agency**]<**Insert entity or specialist**>.

G. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers certified under the National Concrete Masonry Association (NCMA) Certified Segmental Retaining Wall Installer program at the [**Basic**][**Advanced Commercial**] certification level.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.
3. Testing Agency: Qualified in accordance with ASTM E329 for testing indicated.

1.6 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall [**as indicated on Drawings**][**approximately 72 inches (1800 mm) long by not less than 36 inches (900 mm) high above finished grade at front of wall**].

a. Include typical soil reinforcement.
b. Include typical base and cap or finished top construction.
c. Include backfill to typical finished grades at both sides of wall.
d. Include typical end construction at one end of mockup.
e. Include **36-inch (900-mm)** return at one end of mockup, with typical corner construction.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil reinforcement and backfill materials for pullout resistance in accordance with ASTM D6706.
2. Test soil reinforcement and backfill materials for coefficient of friction in accordance with ASTM D5321/D5321M.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above **160 deg F (71 deg C)** or below **32 deg F (0 deg C)**, and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls.

B. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

C. Structural Performance: Engineering design shall be based on the following loads and be in accordance with [**NCMA's "Design Manual for Segmental Retaining Walls."**]<**Insert applicable requirement.**>

1. Gravity loads due to soil pressures resulting from grades[**and sloped backfill**] indicated.
2. Superimposed loads (surcharge) indicated on Drawings.
3. Horizontal Peak Ground Acceleration (A) for Project: <**Insert value**>.

2.2 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C1372, Normal Weight, except that[**maximum water absorption shall not exceed 7 percent by weight and**] units shall not differ in height more than plus or minus **1/16 inch (1.6 mm)** from specified dimension.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allan Block Corporation**]
b. [**Anchor Wall Systems, Inc**]
c. [**CornerStone Wall Solutions Inc.**]
d. [**GeoStone Retaining Wall Systems, Inc.**]
e. [**Keystone Retaining Wall Systems LLC**]
f. [**Nicolock**]
g. [**Risi Stone Inc.**]
h. [**Rockwood Retaining Walls, Inc.**]
i. [**Select ICD; Innovative Concrete Design Corporation**]
j. [**Stone Strong Systems**]
k. [**Tensar International Corporation**]
l. [**Versa-Lok Retaining Wall Systems**]
m. [**WestBlock Systems**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allan Block Corporation**]
b. [**Anchor Wall Systems, Inc**]
c. [**CornerStone Wall Solutions Inc.**]
d. [**GeoStone Retaining Wall Systems, Inc.**]
e. [**Keystone Retaining Wall Systems LLC**]

f. [**Nicolock**]
g. [**Risi Stone Inc.**]
h. [**Rockwood Retaining Walls, Inc.**]
i. [**Select ICD; Innovative Concrete Design Corporation**]
j. [**Stone Strong Systems**]
k. [**Tensar International Corporation**]
l. [**Versa-Lok Retaining Wall Systems**]
m. [**WestBlock Systems**]
n. <**Insert manufacturer's name**>

3. Provide units that comply with requirements in ASTM C1372 for freeze-thaw durability[**as determined by testing**].
4. Provide units that interlock with courses above and below by means of [**integral lugs, lips, or tongues and grooves**][**pins**][**clips**][**splines**][**or**][**and**][**hollow cores filled with drainage fill**].

B. Regional Materials: Units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Units shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**].

G. Shape and Texture:

1. Provide units with [**machine-split textured**][**smooth**], [**flat exposed face**][**shaped exposed face with deeply beveled vertical edges**].

a. Face Dimensions:

1) [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**]<**Insert dimension**> high by [**12 inches (300 mm)**][**16 inches (400 mm)**][**18 inches (460 mm)**]<**Insert dimension**> long.
2) Mix of sizes providing appearance of random range ashlar stone masonry.
3) As indicated.

2. Provide units matching basic shape, dimensions, and face texture of basis-of-design product.
3. Provide units of any basic shape and dimensions that produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with [**machine-split textured**][**smooth**], [**flat exposed face**][**shaped exposed face with deeply beveled vertical edges**].

H. Batter: Provide units that offset from course below to provide [**at least**][**1:24**][**1:16**][**1:14**][**1:8**][**1:5**] batter.

I. Cap Units: Provide cap units of [**shape indicated**][**same shape as other units**] with smooth, as-cast top surfaces without holes or lugs.

J. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces [**matching face**][**as indicated**].

2.3 INSTALLATION MATERIALS

A. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

B. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

C. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

D. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for [**base**][**drainage**] course.

1. Leveling Course: Lean concrete with a compressive strength of not more than **500 psi (3.4 MPa)**.

E. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course.

F. Reinforced Soil Fill:

1. Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.
2. ASTM D2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; complying with the following gradation in accordance with ASTM C136/C136M: 20 to 100 percent passing **No. 4 (4.75 mm)** sieve, zero to 60 percent passing **No. 40 (0.425 mm)** sieve, zero to 35 percent passing **No. 200 (0.075 mm)** sieve, and with fine fraction having a plasticity index of less than 20.

G. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

H. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

I. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation of greater than 50 percent.

1. Apparent Opening Size: **No. 70 to 100 (0.212 to 0.150 mm)** sieve, maximum; ASTM D4751.
2. Minimum Grab Tensile Strength: **110 lb (49.9 kg)**; ASTM D4632/D4632M.
3. Minimum Weight: **4 oz./sq. yd. (132 g/sq. m)**.

J. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanes Geo Components; Leggett & Platt Incorporated**]
b. [**Huesker International**]
c. [**Low & Bonar PLC**]
d. [**Luckenhaus Technical Textiles, Inc.**]
e. [**Propex Operating Company, LLC**]
f. [**Strata Systems, Inc**]
g. [**Synteen Technical Fabrics, Inc.**]
h. [**Tenax Corporation**]
i. [**TenCate Geosynthetics**]
j. [**Tensar International Corporation**]
k. [**Versa-Lok Retaining Wall Systems**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hanes Geo Components; Leggett & Platt Incorporated**]
b. [**Huesker International**]
c. [**Low & Bonar PLC**]
d. [**Luckenhaus Technical Textiles, Inc.**]
e. [**Propex Operating Company, LLC**]
f. [**Strata Systems, Inc**]
g. [**Synteen Technical Fabrics, Inc.**]
h. [**Tenax Corporation**]
i. [**TenCate Geosynthetics**]
j. [**Tensar International Corporation**]
k. [**Versa-Lok Retaining Wall Systems**]
l. <**Insert manufacturer's name**>

3. Product Type: [**Knitted or woven geogrid made from polyester yarns with a protective coating**][**Molded geogrid made from high-density polyethylene**][**Woven geotextile made from polyamides, polyesters, or polyolefins**].

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect each roll of soil reinforcement for minimum average roll values for geosynthetic index property tests, including the following:

1. Weight.
2. Grab or single-rib strength.
3. Aperture opening.
4. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF RETAINING WALLS

A. General: Place units in accordance with NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

1. Lay units in [**running bond**][**bond pattern indicated**].
2. Form corners and ends by [**using special units**][**cutting units with motor-driven saw**][**or**][**splitting units with mason's hammer and chisel**].

B. Do not use units with chips, cracks, or other defects that are visible at a distance of **20 feet (6 m)** where such defects are exposed in the completed Work.

C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight in accordance with ASTM D698.

1. Leveling Course: [**At Contractor's option, unreinforced lean concrete may be substituted for upper 1 to 2 inches (25 to 50 mm) of base**][**Place unreinforced lean concrete over leveling base 1 to 2 inches (25 to 50 mm) thick**]. Compact and screed concrete to a smooth, level surface.

D. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
4. For units with pins, install pins and align units.
5. For units with clips, install clips and align units.

F. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 312000 "Earth Moving," with NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within **48 inches (1200 mm)** of wall or one-half of height above bottom of wall, whichever is greater.

2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight in accordance with ASTM D698.

    a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight in accordance with ASTM D698.
    b. In areas where fill height exceeds **15 feet (4.5 m),)** compact reinforced-soil fill that will be more than **15 feet (4.5 m)** below finished grade to not less than 98 percent maximum dry unit weight in accordance with ASTM D698.
    c. In areas where fill height exceeds **30 feet (9 m),)** compact reinforced-soil fill that will be more than **30 feet (9 m)** below finished grade to not less than 100 percent maximum dry unit weight in accordance with ASTM D698.

3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

D. Place drainage geotextile against back of wall, and place layer of drainage fill at least [**12 inches (300 mm)**][**6 inches (150 mm)**] wide behind drainage geotextile to within **12 inches (300 mm)** of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

E. Place a layer of drainage fill at least [**12 inches (300 mm)**][**6 inches (150 mm)**] wide behind wall to within **12 inches (300 mm)** of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

F. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated[**, sloped not less than 0.5 percent to drain**].

G. Place impervious fill over top edge of drainage fill layer.

H. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.

I. Place soil reinforcement in horizontal joints of retaining wall where indicated and in accordance with soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of **8 inches (200 mm)** into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
2. Place geosynthetics with seams, if any, oriented perpendicularly to segmental retaining walls.
3. Do not dump fill material directly from trucks onto geosynthetics.
4. Place at least **6 inches (150 mm)** of fill over reinforcement before compacting with tracked vehicles or **4 inches (100 mm)** before compacting with rubber-tired vehicles.
5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed **1-1/4 inches in 10 feet (32 mm in 3 m)**, **3 inches (75 mm)** maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than **1-1/4 inches in 10 feet (32 mm in 3 m)**.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than **1-1/4 inches in 10 feet (32 mm in 3 m)**.

D. Maximum Gap between Units: **1/8 inch (3 mm)**.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

C. Tests and Inspections:

1. In each compacted backfill layer, perform at least one field in-place compaction test for each [**150 feet (45 m)**]<**Insert dimension**> or less of segmental retaining wall length.
2. In each compacted backfill layer, perform at least one field in-place compaction test for each [**24 inches (600 mm)**]<**Insert dimension**> of fill depth and each [**50 feet (15 m)**]<**Insert dimension**> or less of segmental retaining wall length.
3. Segmental retaining wall system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
2. Segmental retaining walls that do not match approved Samples[**and mockups**].
3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 32 32 23 00

Task	Specification	Specification Description
32 32 23 13	32 32 23 00	Segmental Retaining Walls
32 32 26 00	32 32 23 00	Segmental Retaining Walls
32 32 29 00	32 32 23 00	Segmental Retaining Walls
32 32 53 00	32 32 23 00	Segmental Retaining Walls

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Task	Specification	Specification Description
33 01 10 54	33 01 30 41	Cleaning of Sewers
33 01 10 58	33 01 30 41	Cleaning of Sewers

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SECTION 33 01 30 41 - CLEANING OF SEWERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers sewer line cleaning. Cleaning procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit product data and manufacturer's instruction.

1.2 PRODUCTS

A. All materials shall be clean, free of defects, corrosion, and damage. All items shall be of proper type, size, design, and characteristics for the use intended. Unless otherwise specified, all items shall be factory-made.

B. Portable Cleaning Equipment: Equipment used in the cleaning of sewer lines shall be as required to complete the work for the size, length, and conditions of the sewer. Portable and mobile equipment shall comply with Water Pollution Control Federation Manual No. 7.

C. Chemicals shall be of the strength required to perform the work. The chemicals shall not be damaging to pipe materials, manholes, pumping equipment, nor treatment process and shall not be contaminated by foreign substances.

1.3 EXECUTION

A. Preparation
   1. Protection required to prevent damage to adjacent materials, equipment, fixtures, and finishes shall be provided. Necessary protective clothing and accessories for personnel working with chemicals shall be provided.
   2. Ventilation of Sewers: Contractor shall provide proper ventilation for personnel working in the sewer.
   3. Alternate Sewage Discharge: Contractor shall provide an alternate routing of sewage discharge to a downstream manhole.
   4. Traffic: Contractor shall provide all traffic signs required to safely direct traffic at and around work areas.

B. Installation
   1. Direction of Work: Sewer line cleaning work, with the exception of hydraulic scouring, shall proceed in the downstream direction. Cleaning by hydraulic scouring shall proceed in the upstream direction.
   2. Testing: Upon completion of cleaning operation, test sewer lines for proper operation and observe for a period of 24 hours. Clean out all stoppages and the retest the line for proper operation.

END OF SECTION 33 01 30 41

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Task	Specification	Specification Description
33 01 30 42	33 01 30 41	Cleaning of Sewers
33 01 30 81	26 05 43 00a	Underground Ducts and Utility Structures
33 01 30 81	33 42 00 00	Stormwater Conveyance
33 01 40 00	33 42 00 00	Stormwater Conveyance

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SECTION 33 05 00 00 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Piping joining materials.
2. Transition fittings.
3. Dielectric fittings.
4. Sleeves.
5. Identification devices.
6. Grout.
7. Flowable fill.
8. Piped utility demolition.
9. Piping system common requirements.
10. Equipment installation common requirements.
11. Painting.
12. Concrete bases.
13. Metal supports and anchorages.

1.2 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. ABS: Acrylonitrile-butadiene-styrene plastic.

D. CPVC: Chlorinated polyvinyl chloride plastic.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Identification devices.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.

C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness, unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, **1/8 inch (3.2 mm)** thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D2235.
2. CPVC Piping: ASTM F493.
3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
4. PVC to ABS Piping Transition: ASTM D3138.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 TRANSITION FITTINGS

A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:

1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 (DN 50) and Larger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Dresser Utility Solutions**]
c. [**Ford Meter Box Company, Inc. (The)**]
d. [**JCM Industries, Inc**]
e. [**Smith-Blair, a Xylem brand.**]
f. [**Viking Johnson**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Dresser Utility Solutions**]
c. [**Ford Meter Box Company, Inc. (The)**]
d. [**JCM Industries, Inc**]
e. [**Smith-Blair, a Xylem brand.**]

f. [**Viking Johnson**]
g. <**Insert manufacturer's name**>

3. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Spears Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Spears Manufacturing Company**]
b. <**Insert manufacturer's name**>

3. Description: [**CPVC**][**CPVC and PVC**][**PVC**] one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint[**or threaded**] end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Colonial Engineering, Inc.**]
b. [**NIBCO INC.**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Colonial Engineering, Inc.**]
b. [**NIBCO INC.**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

3. Description: MSS SP-107, [**CPVC**][**CPVC and PVC**][**PVC**] four-part union. Include brass[**or stainless steel**] threaded end, solvent-cement-joint[**or threaded**] plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Fernco Inc**]
c. [**Mission Rubber Company, LLC**]
d. [**Plastic Oddities**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Fernco Inc**]
c. [**Mission Rubber Company, LLC**]
d. [**Plastic Oddities**]
e. <**Insert manufacturer's name**>

3. Description: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.3 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Capitol Manufacturing Company**]
b. [**Epco Sales, Inc**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**HART Industrial Unions, LLC**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Capitol Manufacturing Company**]
b. [**Epco Sales, Inc**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**HART Industrial Unions, LLC**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Description: Factory fabricated, union, **NPS 2 (DN 50)** and smaller.

a. Pressure Rating: [150 psig (1035 kPa) **minimum**][250 psig (1725 kPa)] at 180 deg F (82 deg C).
b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Capitol Manufacturing Company**]
b. [**Epco Sales, Inc**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Capitol Manufacturing Company**]
b. [**Epco Sales, Inc**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.

a. Pressure Rating: [150 psig (1035 kPa) **minimum**][175 psig (1200 kPa) **minimum**][300 psig (2070 kPa)].
b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]

b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

3. Description: Nonconducting materials for field assembly of companion flanges, **NPS 2-1/2 (DN 65)** and larger.

a. Pressure Rating: [**150 psig (1035 kPa) minimum**]<**Insert pressure**>.
b. Gasket: Neoprene or phenolic.
c. Bolt Sleeves: Phenolic or polyethylene.
d. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CALPICO, Inc.**]
b. [**Lochinvar, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CALPICO, Inc.**]
b. [**Lochinvar, LLC**]
c. <**Insert manufacturer's name**>

3. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, **NPS 3 (DN 80)** and smaller.

a. Pressure Rating: **300 psig (2070 kPa)** at **225 deg F (107 deg C)**.
b. End Connections: Threaded.

F. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elster Perfection; Honeywell**]
b. [**Precision Plumbing Products**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Elster Perfection; Honeywell**]
b. [**Precision Plumbing Products**]

c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

3. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.

a. Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert pressure and temperature**>.
b. End Connections: Threaded or grooved.

2.4 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Section 220500 "Common Work Results for Plumbing."

B. Galvanized-Steel Sheet Sleeves: **0.0239-inch (0.6-mm)** minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.5 IDENTIFICATION DEVICES

A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
2. Location: Accessible and visible.

C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is **1-1/4 inches (30 mm)** for ducts, and **3/4 inch (20 mm)** for access door signs and similar operational instructions.

1. Material: [**Fiberboard**][**Brass**].
2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

F. Pipes with OD, Including Insulation, Less Than **6 Inches (150 mm)**: Full-band pipe markers, extending 360 degrees around pipe at each location.

G. Pipes with OD, Including Insulation, **6 Inches (150 mm)** and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

H. Lettering:

1. Manufacturer's standard preprinted captions as selected by Architect.
2. Use piping system terms indicated and abbreviate only as necessary for each application length.

    a. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

I. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least **3 mils (0.08 mm)** thick.

1. Width: **1-1/2 inches (40 mm)** on pipes with OD, including insulation, less than **6 inches (150 mm)**; **2-1/2 inches (65 mm)** for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

J. Valve Tags: Stamped or engraved with **1/4-inch (6.4-mm)** letters for piping system abbreviation and **1/2-inch (13-mm)** sequenced numbers. Include **5/32-inch (4-mm)** hole for fastener.

1. Material:

    a. **0.032-inch- (0.8-mm-)** thick, [**polished brass**][**or**][**aluminum**].
    b. **0.0375-inch- (1-mm-)** thick stainless steel.
    c. **3/32-inch- (2.4-mm-)** thick plastic laminate with 2 black surfaces and a white inner layer.
    d. Valve manufacturer's standard solid plastic.

2. Size: **1-1/2 inches (40 mm)** in diameter, unless otherwise indicated.
3. Shape: As indicated for each piping system.

K. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

L. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
2. Thickness:

    a. [**1/16 inch (1.6 mm)**][**1/8 inch (3 mm)**], unless otherwise indicated.
    b. **1/16 inch (1.6 mm)**, for units up to **20 sq. in. (130 sq. cm)** or **8 inches (200 mm)** in length, and **1/8 inch (3 mm)** for larger units.

3. Fasteners: Self-tapping, stainless steel screws or contact-type permanent adhesive.

M. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Brown: Energy reclamation equipment and components.
4. Blue: Equipment and components that do not meet criteria above.
5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
6. Terminology: Match schedules as closely as possible. Include the following:

    a. Name and plan number.
    b. Equipment service.
    c. Design capacity.
    d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: **2-1/2 by 4 inches (65 by 100 mm)** for control devices, dampers, and valves; **4-1/2 by 6 inches (115 by 150 mm)** for equipment.

N. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.

1. Size: **3-1/4 by 5-5/8 inches (83 by 143 mm)**.
2. Fasteners: Brass grommets and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

O. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.6 GROUT

A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: **5000-psi (34.5-MPa)**, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.7 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C150, Type I, portland.
2. Density: [**115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. m)**]<**Insert value**>.
3. Aggregates:

    a. ASTM C33, natural sand, fine and crushed gravel or stone, coarse.
    b. ASTM C33, natural sand, fine.

4. Admixture: ASTM C618, fly-ash mineral.
5. Water: Comply with ASTM C94/C94M.

6. Strength: [**100 to 200 psig (690 to 1380 kPa)**]<**Insert value**> at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Refer to Section 024119 "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 (DN 50) and Smaller: Dielectric unions.
2. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges[**or dielectric flange kits**].

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 (DN 50) and Smaller: Dielectric [**couplings**][**couplings or dielectric nipples**][**nipples**].
2. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.
3. NPS 2-1/2 to NPS 8 (DN 65 to DN 200): Dielectric nipples[**or dielectric flange kits**].
4. NPS 10 and NPS 12 (DN 250 and DN 300): Dielectric flange kits.

3.3 INSTALLATION OF PIPING

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas [**2 inches (50 mm)**]<**Insert dimension**> above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

a. Pipe Sleeves: [**PVC**][**Steel**]. For pipes smaller than **NPS 6 (DN 150)**.
b. Steel Sheet Sleeves: For pipes **NPS 6 (DN 150)** and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

H. Soldered Joints: Apply ASTM B813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B32.

I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.
3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
5. PVC Nonpressure Piping: Join according to ASTM D2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138Appendix.

L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.

N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

3.6 INSTALLATION OF EQUIPMENT

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect

equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.7 PAINTING

A. Painting of piped utility systems, equipment, and components is specified in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Stenciled Markers: According to ASME A13.1.
2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
3. Locate pipe markers on exposed piping according to the following:

    a. Near each valve and control device.
    b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
    c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
    d. At manholes and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

1. Lettering Size: Minimum **1/4 inch (6.4 mm)** high for name of unit if viewing distance is less than **24 inches (610 mm)**, **1/2 inch (13 mm)** high for distances up to **72 inches (1800 mm)**, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.9 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than **4 inches (100 mm)** larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use [**3000-psi (20.7-MPa)**]<**Insert strength**>, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.11 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 33 05 00 00

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Task	Specification	Specification Description
33 05 05 43	33 01 30 41	Cleaning of Sewers
33 05 07 00	33 05 00 00	Common Work Results For Utilities
33 05 07 13	33 05 00 00	Common Work Results For Utilities
33 05 07 23	33 05 00 00	Common Work Results For Utilities
33 05 07 24	33 05 00 00	Common Work Results For Utilities
33 05 09 00	33 05 00 00	Common Work Results For Utilities
33 05 09 13	33 05 00 00	Common Work Results For Utilities
33 05 09 23	33 05 00 00	Common Work Results For Utilities
33 05 09 33	33 05 00 00	Common Work Results For Utilities
33 05 16 00	33 05 00 00	Common Work Results For Utilities
33 05 17 00	33 05 00 00	Common Work Results For Utilities
33 05 19 00	33 05 00 00	Common Work Results For Utilities
33 05 24 00	33 05 00 00	Common Work Results For Utilities
33 05 24 23	33 05 00 00	Common Work Results For Utilities
33 05 27 00	33 05 00 00	Common Work Results For Utilities
33 05 27 13	33 05 00 00	Common Work Results For Utilities
33 05 27 23	33 05 00 00	Common Work Results For Utilities
33 05 27 33	33 05 00 00	Common Work Results For Utilities
33 05 31 00	33 05 00 00	Common Work Results For Utilities
33 05 31 11	33 05 00 00	Common Work Results For Utilities
33 05 31 13	33 05 00 00	Common Work Results For Utilities
33 05 31 16	33 05 00 00	Common Work Results For Utilities
33 05 33 00	33 05 00 00	Common Work Results For Utilities
33 05 33 13	33 05 00 00	Common Work Results For Utilities
33 05 33 23	33 05 00 00	Common Work Results For Utilities
33 05 33 33	33 05 00 00	Common Work Results For Utilities
33 05 33 36	33 05 00 00	Common Work Results For Utilities
33 05 33 53	33 05 00 00	Common Work Results For Utilities
33 05 33 56	33 05 00 00	Common Work Results For Utilities
33 05 33 63	33 05 00 00	Common Work Results For Utilities
33 05 39 00	33 05 00 00	Common Work Results For Utilities
33 05 39 13	33 05 00 00	Common Work Results For Utilities
33 05 39 41	33 05 00 00	Common Work Results For Utilities
33 05 39 46	33 05 00 00	Common Work Results For Utilities
33 05 41 00	33 05 00 00	Common Work Results For Utilities
33 05 61 00	33 05 00 00	Common Work Results For Utilities
33 05 61 00	33 42 00 00	Stormwater Conveyance
33 05 63 00	26 05 43 00a	Underground Ducts and Utility Structures
33 05 63 00	33 05 00 00	Common Work Results For Utilities
33 05 81 00	26 05 43 00a	Underground Ducts and Utility Structures
33 05 81 00	33 05 00 00	Common Work Results For Utilities
33 05 81 00	33 42 00 00	Stormwater Conveyance
33 05 83 00	26 05 43 00a	Underground Ducts and Utility Structures
33 05 83 00	33 05 00 00	Common Work Results For Utilities
33 05 83 00	33 42 00 00	Stormwater Conveyance
33 05 84 00	33 05 00 00	Common Work Results For Utilities
33 05 84 00	33 42 00 00	Stormwater Conveyance
33 05 97 00	33 05 00 00	Common Work Results For Utilities
33 05 97 16	33 05 00 00	Common Work Results For Utilities
33 05 97 23	33 05 00 00	Common Work Results For Utilities

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SECTION 33 11 13 00 - REHABILITATION OF WATER SUPPLY WELLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for repair and maintenance of water wells. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Repair and Replacement Parts shall be clean, free of rust and scale, and of proper size and design for the specific well repair to be made.

1.3 EXECUTION

A. Cement Grout may be hand mixed at the site.

B. Level and Re-Sod Area, after heavy equipment has been used or if chemicals have been spilled.

C. Abandoned Wells shall be sealed in accordance with AWWA A100.

D. Disinfect well, after repair, in accordance with AWWA A100.

END OF SECTION 33 11 13 00

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SECTION 33 11 13 00A - POTABLE WATER SUPPLY WELLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Well casings.
2. Grout.
3. Water well screens.
4. Pack materials.
5. Jet well pumps.
6. Line-shaft well pumps.
7. Submersible well pumps.

1.2 ALLOWANCES

A. Allowance amounts and quantities are specified in Section 012100 "Allowances."

1. Water Supply Well Depth Allowance: Install complete and functional well to depth indicated in Section 012100 "Allowances." If water supply well depths vary from quantities in the allowance, the Contract Sum will be adjusted according to unit prices listed in "Unit Prices" Article. Include the following in the Contract Amount:

   a. Labor for water supply well installation.
   b. Furnishing and installing casing materials, grout, well screen, and packing materials in required diameter to comply with minimum performance requirements specified in the Section Text.
   c. Furnishing and installing well pump.

B. Water supply wells and well pumps are covered by cash allowance.[**Allowance includes labor and materials.**]

C. Well pumps are covered by cash allowance.[**Allowance includes labor and materials.**]

1.3 UNIT PRICES

A. Unit-Price Amounts: As stipulated in the Form of Agreement.

B. Measurement and Payment Procedures: Specified in Section 012200 "Unit Prices."

C. Measurement Units for Water Supply Wells, Casings, and Grout: Per linear **foot** **(meter)** of well depth.

1.4 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. PA: Polyamide (nylon) plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

1.5 ACTION SUBMITTALS

A. Product Data: Submit certified performance curves and rated capacities of selected well pumps and furnished specialties and accessories for each type and size of well pump indicated.

B. Shop Drawings: For well pumps. Show layout and connections.

1. Include diagrams for power, signal, and control wiring.
2. Setting Drawings: Include templates and directions for installing foundation bolts, anchor bolts, and other anchorages.

1.6 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. For each well pump, include the following:

a. Substrata formations.
b. Water-bearing formations.
c. Water levels.
d. Laboratory water analysis.
e. Well-screen analysis.
f. Performance test data.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each well pump to include in emergency, operation, and maintenance manuals.

1. Project Record Documents: Record the following data for each water supply well:

a. Casings: Material, diameter, thickness, weight per **foot** **(meter)** of length, and depth below grade.
b. Screen: Material, construction, diameter, and opening size.
c. Pumping Test: Static water level, maximum safe yield, and drawdown at maximum yield.
d. Log: Formation log indicating strata encountered.
e. Alignment: Certification that well is aligned and plumb within specified tolerances.

1.8 QUALITY ASSURANCE

A. Well Driller Qualifications: An experienced water supply well driller licensed in the jurisdiction where Project is located.

B. Testing Agency Qualifications: Certified by the EPA or State to analyze drinking water for compliance monitoring.

1.9 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

B. Well Drilling Water: [**Owner will provide**][**Provide**] temporary water and piping for drilling purposes. Provide necessary piping for water supply.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with AWWA A100 for water supply wells.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Tested Water Supply Well Performance Capacity: <**Insert capacity in gpm (L/s)**>.

2.3 WELL CASINGS

A. Steel Casing: AWWA C200, single ply, steel pipe with threaded ends and threaded couplings for threaded joints.

B. ABS Casing: ASTM F480, ABS, Schedule [**40**][**80**] bell-and-spigot pipe and couplings for solvent-cemented joints.

C. PVC Casing: ASTM F480[**and NSF 14,**] PVC, Schedule [**40**][**80**] bell-and-spigot pipe and couplings for solvent-cemented joints.[**Include NSF listing mark "NSF wc."**]

D. Pitless Adapter: Fitting, of shape required to fit onto casing, with waterproof seals.

E. Pitless Unit: Factory-assembled equipment that includes pitless adapter.

F. Well Seals: Casing cap, with holes for piping and cables, that fits into top of casing and is removable, waterproof, and vermin proof.

2.4 GROUT

A. Cement: ASTM C150/C150M, Type II.

B. Aggregates: ASTM C33/C33M, fine and coarse grades.

C. Water: Potable.

2.5 WATER WELL SCREENS

A. Screen Material: Fabricated of ASTM A666, Type 304 stainless steel[**, welded; with continuous-slot, V-shaped openings that widen inwardly**][**tube; with slotted or perforated surface and designed for well-screen applications**].

1. Screen Couplings: Butt-type, stainless steel coupling rings.
2. Screen Fittings: Screen, with necessary fittings, closes bottom and makes tight seal between top of screen and well casing.
3. Maximum Entering Velocity: **0.1 fps (0.03 m/s)**.

2.6 PACK MATERIALS

A. Coarse, uniformly graded filter sand, maximum **1/8 inch (3 mm)** in diameter.

B. Fine gravel, maximum **1/4 inch (6 mm)** in diameter.

2.7 JET WELL PUMPS

A. Description: [**Shallow**][**Deep**]-well-design, jet well pump; self-priming; centrifugal pump capable of continuous operation.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Goulds Pumps; a brand of Xylem, Inc.**]
3. [**Jacuzzi Inc.**]
4. [**Myers, F.E.; Pentair Ltd**]
5. [**Pentair Pump Group; Layne/Verti-Line**]
6. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Goulds Pumps; a brand of Xylem, Inc.**]
3. [**Jacuzzi Inc.**]
4. [**Myers, F.E.; Pentair Ltd**]
5. [**Pentair Pump Group; Layne/Verti-Line**]
6. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
7. <**Insert manufacturer's name**>

D. Housing: Cast iron.

E. Impeller: [**Single stage**][**Multistage**], centrifugal; fabricated of corrosion-resistant materials.

F. Seals: Mechanical.

G. Shaft: Stainless steel.

H. Motor: Manufacturer's standard, NEMA MG 1 motor, panel, and accessories.

I. Motor Controls: Electronic; variable speed.

J. Check valve, ejector, and pressure-control valve.

K. Pump Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Discharge Head: <**Insert psig (kPa)**>.
3. Discharge Size: <**Insert NPS (DN)**>.
4. Speed: <**Insert rpm**>.
5. Motor Horsepower: <**Insert value**>.
6. Lift: <**Insert feet (m)**>.
7. Pressure Rating: <**Insert psig (kPa)**>.
8. Volts: <**Insert value**>.
9. Phases: <**Insert value**>.
10. Hertz: <**Insert value**>.
11. Full-Load Amperes: <**Insert value**>.
12. Minimum Circuit Ampacity: <**Insert value**>.
13. Maximum Overcurrent Protection: <**Insert amperage**>.
14. Compression Tank Capacity: <**Insert gal. (L)**>.

L. Pump Accessories:

1. Compression Tanks:

a. Comply with requirements in Section 221223 "Facility Indoor Potable-Water Storage Tanks."
b. Precharged butyl rubber diaphragm, steel shell, fused polymeric lining, and **100-psig (690-kPa)** working pressure.

2. Pressure Switches: For pump control; for installation in piping.
3. Water Piping:

a. ASTM A53/A53M, Schedule 40, galvanized-steel pipe with threaded ends.

1) Cast-Iron Fittings: ASME B16.4, threaded, galvanized.

b. ASTM D2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**]. Include NSF listing mark "NSF pw."

1) Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

2.8 LINE-SHAFT WELL PUMPS

A. Description: Line-shaft, [**water**][**oil**]-lubricated, vertical-turbine well pump.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Turbine Pump Co**]
2. [**Crane Pumps & Systems**]
3. [**Fairbanks Morse**]
4. [**Flowserve Corporation**]
5. [**Goulds Pumps; a brand of Xylem, Inc.**]
6. [**Peerless Pump Company**]
7. [**Pentair Pump Group; Layne/Verti-Line**]
8. [**Sulzer Pumps Inc.**]
9. [**WDM Pumps**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Turbine Pump Co**]
2. [**Crane Pumps & Systems**]
3. [**Fairbanks Morse**]
4. [**Flowserve Corporation**]
5. [**Goulds Pumps; a brand of Xylem, Inc.**]
6. [**Peerless Pump Company**]
7. [**Pentair Pump Group; Layne/Verti-Line**]
8. [**Sulzer Pumps Inc.**]
9. [**WDM Pumps**]
10. <**Insert manufacturer's name**>

D. Standards: HI 2.1-2.2 and HI 2.3.

E. Impeller Material: [**Stainless steel**][**Carbon steel**][**Bronze**].

F. Pump Base: Cast iron or fabricated steel.

G. Column Pipe: ASTM A53/A53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Discharge Head: <**Insert psig (kPa)**>.
3. Discharge Size: <**Insert NPS (DN)**>.
4. Speed: <**Insert rpm**>.
5. Motor Horsepower: <**Insert value**>.
6. Lift: <**Insert feet (m)**>.
7. Pressure Rating: <**Insert psig (kPa)**>.
8. Volts: <**Insert value**>.
9. Phases: <**Insert value**>.
10. Hertz: <**Insert value**>.
11. Full-Load Amperes: <**Insert value**>.
12. Minimum Circuit Ampacity: <**Insert value**>.
13. Maximum Overcurrent Protection: <**Insert amperage**>.

2.9 SUBMERSIBLE WELL PUMPS

A. Description: Submersible, vertical-turbine well pump.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Aermotor**]
3. [**American Turbine Pump Co**]
4. [**Crane Pumps & Systems**]
5. [**Goulds Pumps; a brand of Xylem, Inc.**]
6. [**GRUNDFOS CBS Inc.**]
7. [**Jacuzzi Inc.**]
8. [**Myers, F.E.; Pentair Ltd**]
9. [**Peerless Pump Company**]
10. [**Pentair Pump Group; Layne/Verti-Line**]
11. [**Reda Productions Services; Schlumberger Limited**]
12. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
13. [**Sulzer Pumps Inc.**]
14. [**Weber Industries, Inc**]
15. [**Wilo USA LLC**]
16. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Aermotor**]
3. [**American Turbine Pump Co**]
4. [**Crane Pumps & Systems**]
5. [**Goulds Pumps; a brand of Xylem, Inc.**]
6. [**GRUNDFOS CBS Inc.**]
7. [**Jacuzzi Inc.**]
8. [**Myers, F.E.; Pentair Ltd**]
9. [**Peerless Pump Company**]
10. [**Pentair Pump Group; Layne/Verti-Line**]
11. [**Reda Productions Services; Schlumberger Limited**]
12. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
13. [**Sulzer Pumps Inc.**]
14. [**Weber Industries, Inc**]
15. [**Wilo USA LLC**]
16. <**Insert manufacturer's name**>

D. Standards: HI 2.1-2.2 and HI 2.3.

E. Impeller Material: [**Stainless steel**][**Silicon bronze**].

F. Motor: Capable of continuous operation under water, with protected submersible power cable.

G. Column Pipe: ASTM A53/A53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

H. Discharge Piping: ASTM D2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**]. Include NSF

listing mark "NSF pw."

1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

I. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Discharge Head: <**Insert psig (kPa)**>.
3. Discharge Size: <**Insert NPS (DN)**>.
4. Speed: <**Insert rpm**>.
5. Motor Horsepower: <**Insert value**>.
6. Lift: <**Insert feet (m)**>.
7. Pressure Rating: <**Insert psig (kPa)**>.
8. Volts: <**Insert value**>.
9. Phases: <**Insert value**>.
10. Hertz: <**Insert value**>.
11. Full-Load Amperes: <**Insert value**>.
12. Minimum Circuit Ampacity: <**Insert value**>.
13. Maximum Overcurrent Protection: <**Insert amperage**>.

2.10 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

PART 3 - EXECUTION

3.1 PREPARATION

A. Pilot-Hole Data: Review pilot-hole test analysis furnished by Owner.

B. Neighborhood Well Data: Review operating and test analyses.

3.2 INSTALLATION OF WELLS

A. Construct well using [**cable-tool**][**rotary drilling**][**reverse-rotary drilling**][**driven**] method.

B. Take samples of substrata formation at **10-foot (3-m)** intervals and at changes in formation throughout entire depth of each water supply well. Carefully preserve samples on-site in glass jars properly labeled for identification.

C. Excavate for mud pit or provide aboveground structure, acceptable to authorities having jurisdiction, to allow settlement of cuttings and circulation of drill fluids back to well without discharging to on-site waterways.

D. Enlarge pilot hole and install permanent casing, screen, and grout. Install first section of casing with hardened steel driving shoe of an OD slightly larger than casing couplings if threaded couplings are used.

E. Set casing and liners round, plumb, and true to line.

F. Join casing pipe as follows:

1. Ream ends of pipe and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside casing before installation.
3. Cut bevel in ends of casing pipe and make threaded joints.
4. Clean and make solvent-cemented joints.

G. Mix grout in proportions of **1 cu. ft. (0.03 cu. m)** or a **94-lb (42.6-kg)** sack of cement with **5 to 6 gal. (19 to 23 L)** of water. Bentonite clay may be added in amounts of **3 to 5 lb/cu. ft. (1.4 to 2.3 kg/0.03 cu. m)** for a **94-lb (42.6-kg)** sack of cement. If bentonite clay is added, water may be increased to **6.5 gal./cu. ft. (25 L/0.03 cu. m)** of cement.

H. Place grout continuously, from bottom to top surface, to ensure filling of annular space in one operation. Do not perform other operations in well within 72 hours after grouting of casing. When quick-setting cement is used, this period may be reduced to 24 hours.

I. Provide permanent casing with temporary well cap. Install with top of casing **36 inches (910 mm)** above finished grade.

J. Develop wells to maximum yield per **foot (meter)** of drawdown.

1. Extract maximum practical quantity of sand, drill fluid, and other fine materials from water-bearing formation.
2. Avoid settlement and disturbance of strata above water-bearing formation.
3. Do not disturb sealing around well casings.
4. Continue developing wells until water contains no more than 2 ppm of sand by weight when pumped at maximum testing rate.

K. Install jet well pumps with ejector in or attached to pump housing. Place check valve on suction line to prevent drainage of compression tank.

L. Install jet well pumps and pressure and suction lines. Install ejector where pressure and suction lines connect above well screen. Install check valve in suction line, or install foot valve below ejector, to prevent drainage of compression tank.

M. Install [**line-shaft**][**submersible**] well pumps according to HI 2.4 and provide access for periodic maintenance.

1. Before lowering permanent pump into well, lower a dummy pump that is slightly longer and wider than permanent pump to determine that permanent pump can be installed. Correct alignment problems.
2. Before lowering permanent pump into well, start pump to verify correct rotation.
3. Securely tighten discharge piping joints.
4. Locate line-shaft well pump near well bottom; locate motor above grade. Install driver plate to correctly align motor and pump.
5. Connect motor to submersible pump and locate near well bottom.

    a. Connect power cable while connection points are dry and undamaged.
    b. Do not damage power cable during installation; use cable clamps that do not have sharp edges.

c. Install water-sealed surface plate that will support pump and piping.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 331415 "Site Water Distribution Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

1. Connect piping between well pump and water piping.
2. Connect water distribution system in trench to well pipe at pitless [**adapter**][**unit**].
3. Connect building water distribution to well pipe inside well house.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 WELL ABANDONMENT

A. Comply with AWWA A100 when abandoning water supply wells. Fill and seal holes and casings, and restore ground surface to finished grade.

B. Follow well-abandonment procedures of authorities having jurisdiction. Restore ground surface to finished grade.

3.5 FIELD QUALITY CONTROL

A. Test Preparation: Clean water supply wells of foreign substances. Swab casings using alkalis, if necessary, to remove foreign substances.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Plumbness and Alignment Testing: Comply with AWWA A100.
2. Furnish samples of water-bearing formation to testing laboratory and well-screen manufacturer for mechanical sieve analysis.
3. Prepare reports on static level of ground water, level of water for various pumping rates, and depth to water-bearing strata.
4. Performance Test Preparation: Start well pump and adjust controls and pressure setting. Replace damaged and malfunctioning controls and equipment.
5. Performance Testing: Conduct final pumping tests after wells have been constructed, cleaned, and tested for plumbness and alignment.

a. Arrange to conduct tests, with seven days' advance notice, after test pump and auxiliary equipment have been installed. Note water-level elevations referred to for each assigned datum in wells.
b. Provide discharge piping to conduct water to locations where disposal will not create a

nuisance or endanger adjacent property. Comply with requirements of authorities having jurisdiction.

c. Provide and maintain equipment of adequate size and type for measuring flow of water, such as weir box, orifice, or water meter.
d. Measure elevation to water level in wells.
e. Perform two bailer or air-ejection tests to determine expected yield. Test at depths with sufficient quantity of water to satisfy desired yields.
f. Test Pump: Variable capacity test pump with capacity equal to maximum expected yields at pressure equal to drawdown in wells, plus losses in pump columns and discharge pipes.
g. Start and adjust test pumps and equipment to required pumping rates.
h. Record readings of water levels in wells and pumping rates at [**30**]<**Insert number**>-minute maximum intervals throughout 24-hour minimum period.
i. Record maximum yields when drawdown is [**60 inches (1500 mm)**]<**Insert dimension**> above top of suction screens after designated times.
j. Operate pumping units continuously for [**eight**]<**Insert number**> hours after maximum drawdown is reached.
k. Record returning water levels in wells and plot curves of well recovery rates.
l. Remove sand, stones, and other foreign materials that may become deposited in wells after completing final tests.

E. Water supply well will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Water Analysis Testing:

1. [**Owner will engage**][**Engage**] a qualified testing agency to make bacteriological, physical, and chemical analyses of water from each finished well and report the results. Make analyses according to requirements of authorities having jurisdiction.
2. Analyze water sample from each finished well for bacteriological, physical, and chemical quality and report the results. Make analyses according to requirements of authorities having jurisdiction.

3.6 CLEANING

A. Disinfect water supply wells according to AWWA A100 and AWWA C654 before testing well pumps.

B. Follow water supply well disinfection procedures required by authorities having jurisdiction before testing well pumps.

3.7 PROTECTION

A. Water Quality Protection: Prevent well contamination, including undesirable physical and chemical characteristics.

B. Ensure that mud pit will not leak or overflow into streams or wetlands. When well is accepted, remove mud and solids in mud pit from Project site and restore site to finished grade.

C. Provide casings, seals, sterilizing agents, and other materials to eliminate contamination; shut off contaminated water.

D. Exercise care to prevent breakdown or collapse of strata overlaying that from which water is to be drawn.

E. Protect water supply wells to prevent tampering and introducing foreign matter. Retain temporary well

cap until installation is complete.

END OF SECTION 33 11 13 00A

SECTION 33 14 00 00 - SITE WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. PE pipe and fittings.
4. PVC pipe and fittings.
5. Fiberglass pipe and fittings.
6. Special pipe fittings.
7. Piping joining materials.
8. Piping specialties.
9. Encasement for piping.
10. Gate valves.
11. Gate valve accessories and specialties.
12. Check valves.
13. Detector check valves.
14. Butterfly valves.
15. Corporation valves, curb valves, and meter valves.
16. Water meters.
17. Water meter boxes.
18. Pressure-reducing valves.
19. Relief valves.
20. Vacuum breakers.
21. Backflow preventers.
22. Concrete vaults.
23. Protective enclosures.
24. Fire hydrants.
25. Flushing hydrants.
26. Sampling stations.
27. Fire department connections.
28. Alarm devices.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories."
2. Section 032000 "Concrete Reinforcing."
3. Section 211000 "Water-Based Fire-Suppression Systems."
4. Section 221216 "Facility Elevated, Potable-Water Storage Tanks."
5. Section 221219 "Facility Ground-Mounted, Potable-Water Storage Tanks."
6. Section 221223.11 "Facility Indoor Potable-Water Storage Tanks."
7. Section 315000 "Excavation Support and Protection."

1.2 DEFINITIONS

A. CDA: Copper Development Association.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. PA: Polyamide (nylon) plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
2. Include diagrams for power, signal, and control wiring for alarms.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:

1. Ensure that piping, valves, meters, backflow prevention devices, and fire hydrants are dry and internally protected against rust and corrosion.
2. Protect threaded ends and flange faces against damage.
3. Set piping, valves, meters, backflow prevention devices, and fire hydrants in best position for handling and to prevent rattling.

B. During Storage: Use precautions for piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle products if size requires handling by crane or lift. Rig products to avoid

damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.8 COORDINATION

A. Coordinate connection to water main with utility company.

B. Content includes water-distribution piping and related components outside the building for [**domestic water service**][**fire-suppression water service**][**combined domestic water service and fire-suppression water service**][**and terminated 5 ft. (1.5 m) from building**][**and service entrance piping to a point 1 ft. (0.3 m) above finished floor**][**and service entrance piping to a point 1 ft. (0.3 m) inside finished wall**]. Terminate water-service piping with appropriate fitting for extension by [**Division 21**][**Division 22**][**Divisions 21 and 22**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

B. Comply with standards of authorities having jurisdiction for domestic water-service piping, including materials, installation, testing, and disinfection.

C. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and

application.

F. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

G. Comply with FM Approvals' "Approval Guide" and/or UL's "Fire Protection Equipment Directory" for fire-suppression water-service products.

H. Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

I. All piping and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372 or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and service sizes.

B. Potable-water piping and components comply with NSF 14, NSF 61, and NSF 372.[**Include marking "NSF-pw" on piping.**]

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**].

B. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**].

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

E. Copper Tube, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
    c. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
    d. [**Mueller Streamline Co.; a company of Mueller Industries**]
    e. [**NIBCO INC.**]
    f. [**Viega LLC**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
c. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
d. [**Mueller Streamline Co.; a company of Mueller Industries**]
e. [**NIBCO INC.**]
f. [**Viega LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain copper tube, pressure-seal-joint fittings from single manufacturer.
4. Standard: UL 213.
5. Fittings: Cast brass, cast bronze, or wrought copper with EPDM O-ring seal in each end. **NPS 2-1/2 (DN 65)** and larger with stainless steel grip ring and EPDM O-ring seal.
6. Minimum **200 psig (1379 kPa)** working-pressure rating at **250 deg F (121 deg C)**.

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

G. Cast-Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock-body, ball-and-socket, metal-to-metal seating surfaces; and solder-joint or threaded ends.

H. Wrought-Copper Unions: ASME B16.22.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. AWWA C104/A21.4 cement mortar-lined.

B. Mechanical-Joint, Ductile-Iron Fittings:

1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
3. AWWA C104/A21.4 cement mortar-lined.

C. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. AWWA C104/A21.4 cement mortar-lined.

D. Push-on-Joint, Ductile-Iron Fittings:

1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
2. Gaskets: AWWA C111/A21.11, rubber.
3. AWWA C104/A21.4 cement mortar-lined.

E. Grooved-End, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with cut, rounded-grooved ends.
2. AWWA C104/A21.4 cement mortar-lined.

F. Grooved-End, Ductile-Iron Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**GroovJoint**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Smith-Cooper International**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**GroovJoint**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Smith-Cooper International**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain grooved-end, ductile-iron pipe appurtenances from single manufacturer.
4. Grooved-End, Ductile-Iron Fittings:

   a. ASTM A536, ductile-iron castings with dimensions matching pipe.
   b. AWWA C104/A21.4 cement mortar-lined.

5. Grooved-End, Ductile-Iron-Piping Mechanical Couplings:

   a. AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

G. Flanges: ASME 16.1, Class 125, cast iron.

2.5 PE PIPE AND FITTINGS

A. PE, ASTM Pipe: ASTM D2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**].

1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
2. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than [160 psig (1100 kPa)][200 psig (1380 kPa)].

1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than [160 psig (1100 kPa)][200 psig (1380 kPa)].

C. PE, Fire-Service Pipe: ASTM F714, AWWA C906, or equivalent for PE water pipe; FM Global approved, with minimum thickness equivalent to FM Global [**Class 150**][**and**][**Class 200**].

1. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, and made to match PE pipe dimensions and class.

2.6 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

B. PVC, Schedule 80 Pipe: ASTM D1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

C. PVC Pipe: [**AWWA C900**][**UL 1285**], [**Class 150**][**and**][**Class 200**], with bell end with gasket, and with spigot end.

1. Comply with UL 1285 for fire-suppression water service.
2. PVC Fabricated Fittings: AWWA C900, [**Class 150**][**and**][**Class 200**], with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

2.7 FIBERGLASS PIPE AND FITTINGS

A. RTRP Pipe: AWWA C950, [**Class 150**][**Class 200**][**and**][**Class 250**], Type I[**or II**], [**Grade 1, epoxy**][**or**][**Grade 2, polyester**], with bell-and-spigot ends [**for bonded**][**with gasket or seal for gasketed**] joints. Liner is optional unless otherwise indicated.[**Include FM Global approval if used for fire-service mains.**]

B. Fittings, RTRF, AWWA C950: Similar to pipe in material, pressure class, and joining method.

C. Fittings: Compatible with pipe size, pressure class, and joining method.

2.8 SPECIAL PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, end sections.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**EBAA Iron Sales, Inc.**]
b. [**U.S. Pipe**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EBAA Iron Sales, Inc.**]
b. [**U.S. Pipe**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron rigid expansion joints from single manufacturer.
4. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.

B. Ductile-Iron Flexible Expansion Joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends. Include two gasketed ball-joint sections and one or more gasketed sleeve sections.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EBAA Iron Sales, Inc.**]
b. [**Star Pipe Products**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EBAA Iron Sales, Inc.**]
b. [**Star Pipe Products**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron flexible expansion joints from single manufacturer.
4. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.
6. Offset: <**Insert inches (mm)**>.
7. Expansion Required: <**Insert inches (mm)**>.

C. Ductile-Iron Deflection Fittings, Lead Free: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EBAA Iron Sales, Inc.**]
b. [**U.S. Pipe**]

c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. **[EBAA Iron Sales, Inc.]**
   b. **[U.S. Pipe]**
   c. **<Insert manufacturer's name>**

3. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
4. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.

2.9 PIPING JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

B. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

C. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.10 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

   a. **[Cascade Waterworks Mfg. Co.]**
   b. **[Ford Meter Box Company, Inc. (The)]**
   c. **[JCM Industries, Inc]**
   d. **[Smith-Blair, a Xylem brand.]**
   e. **[United Water Products]**
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. **[Cascade Waterworks Mfg. Co.]**
   b. **[Ford Meter Box Company, Inc. (The)]**
   c. **[JCM Industries, Inc]**
   d. **[Smith-Blair, a Xylem brand.]**

e. [**United Water Products**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain tubular-sleeve pipe couplings from single manufacturer.
4. Standard: AWWA C219.
5. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].
6. Gasket Material: Natural or synthetic rubber.
7. Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert pressure**> minimum.
8. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Pipe Couplings: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Victaulic Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Victaulic Company**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain split-sleeve pipe couplings from single manufacturer.
4. Standard: AWWA C227.
5. Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**].
6. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
7. Gasket Material: O-rings made of EPDM rubber unless otherwise indicated.
8. Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert pressure**> minimum.
9. Metal Component Finish: Corrosion-resistant coating or material.

D. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless steel hose covered with stainless steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

E. Dielectric Fittings: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

1. Dielectric Unions:

a. Standard: ASSE 1079.
b. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**]<**Insert pressure rating and temperature**>.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**]<**Insert pressure rating and temperature**>.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits: Nonconducting materials for field assembly of companion flanges.

a. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure rating**>.
b. Gasket: Neoprene or phenolic.
c. Bolt Sleeves: Phenolic or PE.
d. Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple complying with ASTM F1545.
c. Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert pressure rating and temperature**>.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, PP.

2.11 ENCASEMENT FOR PIPING

A. Standards: ASTM A674 or AWWA C105/A21.5.

B. Form: [**Sheet**][**or**][**tube**].

C. Material: [**Linear low-density PE film of 0.008-inch (0.20-mm) minimum thickness**][**or**][**high-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

2.12 GATE VALVES

A. Gate Valves - AWWA, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**EJ Group, Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**M & H Valve Company; a division of McWane, Inc.**]
g. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
h. [**NIBCO INC.**]
i. [**Zurn Industries, LLC**]

j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**EJ Group, Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**M & H Valve Company; a division of McWane, Inc.**]
g. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
h. [**NIBCO INC.**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain gate valves - AWWA, cast iron, from single manufacturer.
4. Gate Valves - Nonrising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

a. Standards: AWWA C509 or AWWA C515.
b. Minimum Pressure Rating: **200 psig (1380 kPa)**.
c. End Connections: Mechanical joint, flanged, threaded, or push on.
d. Interior Coating: Complying with AWWA C550.

5. Gate Valves - OS&Y, Rising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, and bronze stem.

a. Standard: AWWA C509 or AWWA C515.
b. Minimum Pressure Rating: **200 psig (1380 kPa)**.
c. End Connections: Mechanical joint, flanged, threaded, or push on.

B. Gate Valves - UL/FM Global, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**Kennedy Valve Company; a division of McWane, Inc.**]
e. [**M & H Valve Company; a division of McWane, Inc.**]
f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
g. [**NIBCO INC.**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American AVK Co.**]

b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**Kennedy Valve Company; a division of McWane, Inc.**]
e. [**M & H Valve Company; a division of McWane, Inc.**]
f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
g. [**NIBCO INC.**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain gate valves - UL/FM Global, cast iron, from single manufacturer.
4. Gate Valves - UL/FM Global, Nonrising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with flange for indicator post, bronze seating material, and inside screw.

a. Standards: AWWA C509 or AWWA C515, UL listed and FM Global approved.
b. Minimum Pressure Rating: **175 psig (1207 kPa)**.
c. End Connections: Mechanical joint or flanged.
d. Interior Coating: Complying with AWWA C550.

5. Gate Valves - OS&Y, Rising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet and bronze seating material.

a. Standards: AWWA C509 or AWWA C515, UL listed and FM Global approved.
b. Minimum Pressure Rating: **175 psig (1207 kPa)**.
c. End Connections: Mechanical joint or flanged.
d. Interior Coating: Complying with AWWA C550.

C. Gate Valves - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Hammond Valve**]
c. [**Jenkins Valves; a Crane Co. brand**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. [**Red-White Valve Corp.**]
g. [**Stockham; a Crane Co. brand**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Hammond Valve**]
c. [**Jenkins Valves; a Crane Co. brand**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. [**Red-White Valve Corp.**]
g. [**Stockham; a Crane Co. brand**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain gate valves - bronze, from single manufacturer.

4. Gate Valves - OS&Y, Rising Stem: Bronze body and bonnet and bronze stem.

   a. Standards: UL listed and FM Global approved.
   b. Minimum Pressure Rating: **175 psig (1207 kPa)**.
   c. End Connections: Threaded.

5. Gate Valves - Nonrising Stem: Class 125, bronze with solid wedge.

   a. Standard: MSS SP-80.
   b. End Connections: Threaded or solder.
   c. Handwheel: Malleable iron.

2.13 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies: Sleeve and valve compatible with drilling machine.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Cast Iron Pipe Company**]
   b. [**Kennedy Valve Company; a division of McWane, Inc.**]
   c. [**U.S. Pipe**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Cast Iron Pipe Company**]
   b. [**Kennedy Valve Company; a division of McWane, Inc.**]
   c. [**U.S. Pipe**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain tapping-sleeve assemblies from single manufacturer.
4. Standard: MSS SP-60.
5. Tapping Sleeve: Cast- or ductile-iron or stainless steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
6. Valve: AWWA, cast-iron, nonrising-stem, [**metal**][**resilient**]-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately **5 inches (125 mm)** in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FM Global approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.14 CHECK VALVES

A. Check Valves - AWWA: Swing-check type with resilient seat with ends to match piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**DeZURIK**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**M & H Valve Company; a division of McWane, Inc.**]
g. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
h. [**NIBCO INC.**]
i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**DeZURIK**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**M & H Valve Company; a division of McWane, Inc.**]
g. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
h. [**NIBCO INC.**]
i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain check valves, AWWA, from single manufacturer.
4. Standards:

a. AWWA C508.
b. Interior coating in accordance with AWWA C550.

5. Pressure Rating: **175 psig (1207 kPa)**.

B. Check Valves - UL/FM Global: Swing-check type with pressure rating, rubber-face checks unless otherwise indicated, and ends matching piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Cast Iron Pipe Company**]
b. [**Matco-Norca**]
c. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
d. [**NIBCO INC.**]
e. [**Reliable Automatic Sprinkler Co., Inc. (The)**]

f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American Cast Iron Pipe Company**]
   b. [**Matco-Norca**]
   c. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   d. [**NIBCO INC.**]
   e. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
   f. **<Insert manufacturer's name>**

3. Source Limitations: Obtain check valves - UL/FM Global, from single manufacturer.
4. Standards: UL listed and FM Global approved.
5. Pressure Rating: [**175 psig (1207 kPa)**][**250 psig (1725 kPa)**].

2.15 DETECTOR CHECK VALVES

A. Detector Check Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**FEBCO; A WATTS Brand**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**FEBCO; A WATTS Brand**]
   c. **<Insert manufacturer's name>**

3. Source Limitations: Obtain detector check valves from single manufacturer.

B. Description: Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

1. Standards: UL listed and FM Global approved.
2. Pressure Rating: **175 psig (1207 kPa)**.

C. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2.16 BUTTERFLY VALVES

A. Butterfly Valves - AWWA:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DeZURIK**]
    b. [**Flomatic Valves; Flomatic Corporation**]
    c. [**Henry Pratt Company; a Mueller brand**]
    d. [**Homestead Valve: a division of Olson Technologies, Inc.**]
    e. [**Milliken Valve Company; a Mueller brand.**]
    f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
    g. [**Val-Matic Valve & Manufacturing Corp.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**DeZURIK**]
    b. [**Flomatic Valves; Flomatic Corporation**]
    c. [**Henry Pratt Company; a Mueller brand**]
    d. [**Homestead Valve: a division of Olson Technologies, Inc.**]
    e. [**Milliken Valve Company; a Mueller brand.**]
    f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
    g. [**Val-Matic Valve & Manufacturing Corp.**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain butterfly valves - AWWA, from single manufacturer.
4. Standard: AWWA C504.
5. Body: Cast or ductile iron.
6. Body Type: [**Wafer**][**or**][**flanged**]<**Insert type**>.
7. Seat: Rubber.
8. Pressure Rating: **150 psig (1035 kPa)**.

B. Butterfly Valves - UL:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Henry Pratt Company; a Mueller brand**]
    b. [**NIBCO INC.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Henry Pratt Company; a Mueller brand**]
    b. [**NIBCO INC.**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain butterfly valves - UL, from single manufacturer.
4. Standards: UL 1091 and FM Global approved.
5. Body: Cast or ductile iron.

6. Body Type: [**Wafer**][**or**][**flanged**]<**Insert type**>.
7. Seat: Metal or resilient material.
8. Pressure Rating: **175 psig (1207 kPa)**.

2.17 CORPORATION VALVES, CURB VALVES, AND METER VALVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Ford Meter Box Company, Inc. (The)**]
3. [**James Jones Company, LLC; a Mueller brand**]
4. [**Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Ford Meter Box Company, Inc. (The)**]
3. [**James Jones Company, LLC; a Mueller brand**]
4. [**Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain corporation valves, curb valves, and meter valves from single manufacturer.

D. Corporation Valves: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
2. Corporation Valve: Bronze body, ground-key plug or ball, with AWWA C800, threaded inlet and outlet matching service piping material.
3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

E. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

1. Service Boxes for Curb Valves: ASTM A48/A48M, Class 25 cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately **3 inches (75 mm)** in diameter.

a. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

F. Meter Valves: Comply with AWWA C800 for high-pressure, service-line valves. Include angle or straight-through-pattern bronze body, ground-key plug or ball, wide tee head, with inlet and outlet matching service piping material.

2.18 WATER METERS

A. Water Meter - Utility Company Furnished:

1. Utility Company: <**Insert name**>.

B. Water Meters - Displacement Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Master Meter, Inc**]
d. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
e. [**Neptune Technology Group Inc.**]
f. [**Niagara Meters**]
g. [**Sensus; a Xylem brand**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Master Meter, Inc**]
d. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
e. [**Neptune Technology Group Inc.**]
f. [**Niagara Meters**]
g. [**Sensus; a Xylem brand**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - displacement type, from single manufacturer.
4. Standard: AWWA C700.
5. Pressure Rating: **150 psig (1035 kPa)** working pressure.
6. Body Design: Nutating disc; totalization meter.
7. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**] as required by utility company.
8. Case: [**Bronze**][**Stainless steel**].
9. End Connections: Threaded or flanged <**Insert connection**>.

C. Water Meters - Turbine Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
d. [**Neptune Technology Group Inc.**]
e. [**Niagara Meters**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Badger Meter, Inc.**]
    b. [**Carlon Meter**]
    c. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
    d. [**Neptune Technology Group Inc.**]
    e. [**Niagara Meters**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - turbine type, from single manufacturer.
4. Standard: AWWA C701.
5. Pressure Rating: **150 psig (1035 kPa)** working pressure.
6. Body Design: Turbine; totalization meter.
7. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**] as required by utility company.
8. Case: [**Bronze**][**Epoxy-coated cast iron**].
9. End Connections: Threaded or flanged <**Insert connection**>.

D. Water Meters - Compound Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Badger Meter, Inc.**]
    b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
    c. [**Neptune Technology Group Inc.**]
    d. [**Sensus; a Xylem brand**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Badger Meter, Inc.**]
    b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
    c. [**Neptune Technology Group Inc.**]
    d. [**Sensus; a Xylem brand**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - compound type, from single manufacturer.
4. Standard: AWWA C702.
5. Pressure Rating: **150 psig (1035 kPa)** working pressure.
6. Body Design: With integral mainline and bypass meters; totalization meter.
7. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**] as required by utility company.
8. Case: [**Bronze**][**Coated ductile iron**].
9. End connections: Flanged <**Insert connection**>.

E. Water Meters - Ultrasonic Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Badger Meter, Inc.**]
b. [**Master Meter, Inc**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Master Meter, Inc**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - ultrasonic type, from single manufacturer.
4. Standard: AWWA C715.
5. Pressure Rating: **150 psig (1035 kPa)** working pressure.
6. Body Design: Ultrasonic open flow tube; totalization meter.
7. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**] as required by utility company.
8. Case: [**Bronze**][**Stainless steel**][**Engineered polymer**][**Epoxy-coated ductile iron**]<**Insert type**>.
9. End Connections: Threaded or flanged <**Insert connection**>.

F. Ultrasonic Type Water Meter, Remote Registration System, Direct-Reading Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].

G. Ultrasonic Type Water Meter, Remote Registration System, Encoder Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Standard: AWWA C707.
2. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].
3. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
4. Visible Display Units: Comply with utility company requirements for type and quantity.

H. Water Meters - Detector Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - detector type, from single manufacturer.
4. Standards: AWWA C703, and UL listed or FM Global approved.
5. Pressure Rating: **175 psig (1207 kPa)**.
6. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].
7. Bypass Meter: [**AWWA C700, disc**][**AWWA C701, turbine**][**AWWA C702, compound**]-type, bronze case.

I. Detector Type Water Meter, Remote Registration System, Direct-Reading Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].

J. Detector Type Water Meter, Remote Registration System, Encoder Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Standard: AWWA C707.
2. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].
3. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
4. Visible Display Units: Comply with utility company requirements for type and quantity.

2.19 WATER METER BOXES

A. Water Meter Boxes:

1. Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

a. Option: Base section may be cast-iron, PVC, clay, or other pipe.

2. Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
3. Water Meter Boxes: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of **15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm)** square.

2.20 PRESSURE-REDUCING VALVES

A. Pressure-Reducing Valves - Direct Acting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cash Acme Plumbing Products; an RWC brand**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cash Acme Plumbing Products; an RWC brand**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pressure-reducing valves - direct acting, from single manufacturer.
4. Standard: ASSE 1003.
5. Pressure Rating: Initial pressure of **150 psig (1035 kPa)**.
6. Size: <**Insert NPS (DN)**>.
7. Design Flow Rate: <**Insert gpm (L/s)**>.
8. Design Inlet Pressure: <**Insert psig (kPa)**>.
9. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.
10. Body: Bronze[**with chrome-plated finish**].
11. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; flanged for **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**.

B. Pressure-Reducing Valves - Pilot Operated: Pilot-operation, diaphragm-type, single-seated main water control valve with interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**CLA-VAL**]
c. [**Dorot Control Valves Inc.**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**OCV Control Valves**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**CLA-VAL**]
c. [**Dorot Control Valves Inc.**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**OCV Control Valves**]
f. [**Zurn Industries, LLC**]

g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pressure-reducing valves - pilot operated, from single manufacturer.
4. Pressure Rating: Initial pressure of **150 psig (1035 kPa)** minimum.
5. Main Valve Body: Cast- or ductile-iron, or stainless steel body.
6. Size: <**Insert NPS (DN)**>.
7. Pattern: [**Angle**][**Globe**]-valve design.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Design Inlet Pressure: <**Insert psig (kPa)**>.
10. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.
11. End Connections: [**Threaded**][**or**][**grooved**][**or**][**flanged**].

2.21 RELIEF VALVES

A. Air-Release Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain air-release valves from single manufacturer.
4. Standard: AWWA C512.
5. Pressure Rating: [**300 psig (2070 kPa)**]<**Insert pressure**>.
6. Body Material: [**Cast iron**]<**Insert material**>.
7. Trim Material: Stainless steel[**, brass, or bronze**].
8. Water Inlet Size: <**Insert NPS (DN)**>.
9. Air Outlet Size: <**Insert NPS (DN)**>.
10. Orifice Size: <**Insert inches (mm)**>.
11. Design Air-Release Capacity: <**Insert cfm (L/s)**> at <**Insert psig (kPa)**> pipeline pressure.

B. Air/Vacuum Valves: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain air/vacuum valves from single manufacturer.
4. Standard: AWWA C512.
5. Pressure Rating: [**300 psig (2070 kPa)**]<**Insert pressure**>.
6. Body Material: [**Cast iron**]<**Insert material**>.
7. Trim Material: Stainless steel[**, brass, or bronze**].
8. Inlet and Outlet Size: <**Insert NPS (DN)**>.
9. Orifice Size: <**Insert inches (mm)**>.
10. Design Air Capacity: <**Insert cfm (L/s)**> at <**Insert psig (kPa)**> differential pressure.

C. Combination Air Valves: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain combination air valves from single manufacturer.
4. Standard: AWWA C512.
5. Pressure Rating: [**300 psig (2070 kPa)**]<**Insert pressure**>.
6. Body Material: [**Cast iron**]<**Insert material**>.
7. Trim Material: Stainless steel[**, brass, or bronze**].
8. Inlet and Outlet Size: <**Insert NPS (DN)**>.
9. Orifice Size: <**Insert inches (mm)**>.

10. Design Air Capacity: <**Insert cfm (L/s)**> at <**Insert psig (kPa)**> differential pressure.

2.22 VACUUM BREAKERS

A. Pressure Vacuum Breaker Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**FEBCO; A WATTS Brand**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**FEBCO; A WATTS Brand**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pressure vacuum breaker assembly from single manufacturer.
4. Standard: ASSE 1020.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: [**5 psig (35 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.
7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**>.
11. Accessories: Ball valves on inlet and outlet.

2.23 BACKFLOW PREVENTERS

A. Backflow Preventers - Reduced-Pressure Principle:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventers - reduced-pressure principle, from single manufacturer.
4. Standard: [**ASSE 1013**][**or**][**AWWA C511**].
5. Operation: Continuous-pressure applications.
6. Pressure Loss: [**12 psig (83 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.
7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**> for **NPS 2 (DN 50)** and smaller; <**Insert psig (kPa)**> for **NPS 2-1/2 (DN 65)** and larger.
11. Body: Bronze for **NPS 2 (DN 50)** and smaller; [**cast iron with interior lining complying with AWWA C550 or that is FDA approved**][**steel with interior lining complying with AWWA C550 or that is FDA approved**][**stainless steel**] for **NPS 2-1/2 (DN 65)** and larger.
12. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.
13. Configuration: Designed for [**horizontal, straight through**][**vertical inlet, horizontal center section, and vertical outlet**][**vertical**]<**Insert configuration**> flow.
14. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of **NPS 2 (DN 50)** and smaller; OS&Y gate type with flanged ends on inlet and outlet of **NPS 2-1/2 (DN 65)** and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Backflow Preventers - Double-Check Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]

d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventers - double-check assembly, from single manufacturer.
4. Standard: [**ASSE 1015**][**or**][**AWWA C510**].
5. Operation: Continuous-pressure applications unless otherwise indicated.
6. Pressure Loss: [**5 psig (35 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.
7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**> for **NPS 2 (DN 50)** and smaller; <**Insert psig (kPa)**> for **NPS 2-1/2 (DN 65)** and larger.
11. Body: Bronze for **NPS 2 (DN 50)** and smaller; [**cast iron with interior lining complying with AWWA C550 or that is FDA approved**][**steel with interior lining complying with AWWA C550 or that is FDA approved**][**stainless steel**] for **NPS 2-1/2 (DN 65)** and larger.
12. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.
13. Configuration: Designed for [**horizontal, straight through**]<**Insert configuration**> flow.
14. Accessories: Ball valves with threaded ends on inlet and outlet of **NPS 2 (DN 50)** and smaller; OS&Y gate valves with flanged ends on inlet and outlet of **NPS 2-1/2 (DN 65)** and larger.

C. Backflow Preventers - Reduced-Pressure-Detector, Fire-Protection Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventers - reduced-pressure-detector, fire-protection assembly, from single manufacturer.
4. Standards: ASSE 1047, and UL listed or FM Global approved.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: [**12 psig (83 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.

7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**>.
11. Body: [**Cast iron with interior lining complying with AWWA C550 or that is FDA approved**][**Steel with interior lining complying with AWWA C550 or that is FDA approved**][**Stainless steel**].
12. End Connections: Flanged.
13. Configuration: Designed for [**horizontal, straight through**][**vertical inlet, horizontal center section, and vertical outlet**][**vertical**]<**Insert configuration**> flow.
14. Accessories:

    a. Valves: UL 262, FM Global approved, OS&Y gate type with flanged ends on inlet and outlet.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
    c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

D. Backflow Preventers - Double-Check, Detector Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventers - double-check, detector-assembly, from single manufacturer.
4. Standards: ASSE 1048, and UL listed or FM Global approved.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: [**5 psig (35 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.
7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**>.
11. Body: [**Cast iron with interior lining complying with AWWA C550 or that is FDA approved**][**Steel with interior lining complying with AWWA C550 or that is FDA approved**][**Stainless steel**].

12. End Connections: Flanged.
13. Configuration: Designed for [**horizontal, straight through**][**vertical inlet, horizontal center section, and vertical outlet**][**vertical**]<**Insert configuration**> flow.
14. Accessories:

    a. Valves: UL 262, FM Global approved, OS&Y gate type with flanged ends on inlet and outlet.
    b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

E. Backflow Preventer Test Kits: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventer test kits from single manufacturer.

2.24 CONCRETE VAULTS

A. Concrete Vault - Precast, Reinforced Concrete: Designed for A-16 load designation in accordance with ASTM C857 and made in accordance with ASTM C858.

1. Ladder: ASTM A36/A36M, steel or PE-encased steel steps.
2. Manhole:

    a. ASTM A48/A48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover; **24-inch (610-mm)** minimum diameter unless otherwise indicated.
    b. ASTM A536, Grade 60-40-18, ductile-iron traffic frame and cover: **24-inch (610-mm)** minimum diameter unless otherwise indicated.

3. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.25 PROTECTIVE ENCLOSURES

A. Freeze-Protection Enclosures: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of **40 deg F (4 deg C)** when external temperatures reach as low as **minus 30 deg F (minus 34 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**AquaSHIELD**]
    c. [**BF Products Inc.**]
    d. [**DekoRRa Products LLC**]
    e. [**G&C Enclosures**]
    f. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    g. [**HydroCowl, Inc**]
    h. [**WATTS; A Watts Water Technologies Company**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**AquaSHIELD**]
    c. [**BF Products Inc.**]
    d. [**DekoRRa Products LLC**]
    e. [**G&C Enclosures**]
    f. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    g. [**HydroCowl, Inc**]
    h. [**WATTS; A Watts Water Technologies Company**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freeze-protection enclosures from single manufacturer.
4. Standard: ASSE 1060.
5. Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.
6. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
7. Housing: Reinforced[**-aluminum**][**or**][**-fiberglass**]<**Insert housing**> construction.

    a. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
    b. Drain opening for units with drain connection.
    c. Access doors with locking devices.
    d. Insulation inside housing.
    e. Anchoring devices for attaching housing to concrete base.

8. Electric heating cable or heater with self-limiting temperature control.

B. Freeze-Retardant Enclosures: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage with minimum external temperatures of **33 deg F (0.5 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AquaSHIELD**]
    b. [**BF Products Inc.**]
    c. [**DekoRRa Products LLC**]
    d. [**G&C Enclosures**]
    e. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    f. [**HydroCowl, Inc**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**AquaSHIELD**]
    b. [**BF Products Inc.**]
    c. [**DekoRRa Products LLC**]
    d. [**G&C Enclosures**]
    e. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    f. [**HydroCowl, Inc**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freeze-retardant enclosures from single manufacturer.
4. Standard: ASSE 1060.
5. Class II: For equipment or devices other than pressure or atmospheric vacuum breakers.
6. Class II-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
7. Housing: Reinforced[**-aluminum**][**or**][**-fiberglass**]<**Insert housing**> construction.

    a. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
    b. Drain opening for units with drain connection.
    c. Access doors with locking devices.
    d. Anchoring devices for attaching housing to concrete base.

C. Non-Freeze Protection Enclosures: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AquaSHIELD**]
    b. [**BF Products Inc.**]
    c. [**DekoRRa Products LLC**]
    d. [**G&C Enclosures**]
    e. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    f. [**HydroCowl, Inc**]
    g. [**WATTS; A Watts Water Technologies Company**]

h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AquaSHIELD**]
b. [**BF Products Inc.**]
c. [**DekoRRa Products LLC**]
d. [**G&C Enclosures**]
e. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
f. [**HydroCowl, Inc**]
g. [**WATTS; A Watts Water Technologies Company**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain non-freeze protection enclosures from single manufacturer.
4. Standard: ASSE 1060.
5. Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.
6. Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
7. Housing: Reinforced[**-aluminum**][**or**][**-fiberglass**]<**Insert housing**> construction.

a. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
b. Drain opening for units with drain connection.
c. Access doors with locking devices.
d. Anchoring devices for attaching housing to concrete base.

D. Expanded-Metal Enclosures: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cross Brothers Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cross Brothers Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain expanded-metal enclosures from single manufacturer.
4. Standard: ASTM F1267.
5. Material: Expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
6. Type: [**I, expanded**][**II, expanded and flattened**].
7. Class: [**1, uncoated carbon steel**][**2, hot-dip, zinc-coated carbon steel**][**3, corrosion-resistant steel**].
8. Finish: Manufacturer's enamel paint.
9. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.

10. Locking device.
11. Lugs or devices for securing enclosure to base.

E. Enclosure Bases: [4-inch- (100-mm-)][6-inch- (150-mm-)] minimum thickness precast concrete, of dimensions required to extend at least 6 inches (150 mm) beyond edges of enclosure housings. Include openings for piping.

2.26 FIRE HYDRANTS

A. Fire Hydrants - Dry Barrel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American AVK Co.**]
    b. [**American Cast Iron Pipe Company**]
    c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    d. [**EJ Group, Inc.**]
    e. [**M & H Valve Company; a division of McWane, Inc.**]
    f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American AVK Co.**]
    b. [**American Cast Iron Pipe Company**]
    c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    d. [**EJ Group, Inc.**]
    e. [**M & H Valve Company; a division of McWane, Inc.**]
    f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fire hydrants - dry barrel, from single manufacturer.
4. Pressure Rating: [150 psig (1035 kPa) **minimum**][250 psig (1725 kPa)].
5. Standard: AWWA C502.
6. Freestanding configuration, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating in accordance with AWWA C550. Hydrant to have cast-iron body, compression-type valve opening against pressure and closing with pressure.
7. Standards: UL 246, and FM Global approved.
8. Freestanding configuration, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Hydrant to have cast-iron body, compression-type valve opening against pressure and closing with pressure.

    a. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
    b. Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
    c. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.

d. Exterior Finish: Red alkyd-gloss enamel paint unless otherwise indicated.

B. Fire Hydrants - Wet Barrel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American AVK Co.**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**James Jones Company, LLC; a Mueller brand**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American AVK Co.**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**James Jones Company, LLC; a Mueller brand**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fire hydrants - wet barrel, from single manufacturer.
4. Pressure Rating: **150 psig (1035 kPa)** minimum.
5. Standard: AWWA C503.
6. Freestanding configuration, with one **NPS 4-1/2 (DN 115)** and two **NPS 2-1/2 (DN 65)** outlets, **NPS 6 (DN 150)** threaded or flanged inlet, and base section with **NPS 6 (DN 150)** mechanical-joint inlet. Include interior coating in accordance with AWWA C550.
7. Standards: UL 246, and FM Global approved.
8. Freestanding configuration, with one **NPS 4-1/2 (DN 115)** and two **NPS 2-1/2 (DN 65)** outlets, **NPS 6 (DN 150)** threaded or flanged inlet, and base section with **NPS 6 (DN 150)** mechanical-joint inlet.

   a. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
   b. Operating and Cap Nuts: Pentagon, **1-1/2 inches (38 mm)** point to flat.
   c. Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
   d. Exterior Finish: Red alkyd-gloss enamel paint unless otherwise indicated.

2.27 FLUSHING HYDRANTS

A. Flushing Hydrants - Post Type: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GIL Industries, Inc**]
   b. [**Kupferle Foundry Co. (The)**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**GIL Industries, Inc**]
    b. [**Kupferle Foundry Co. (The)**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain flushing hydrants - post type, from single manufacturer.
4. Pressure Rating: **150 psig (1035 kPa)** minimum.
5. Outlet: One, with horizontal discharge.
6. Hose Thread: **NPS 2-1/2 (DN 65)**, with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
7. Barrel: Cast-iron or steel pipe with breakaway feature.
8. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
9. Security: Locking device for padlock.
10. Exterior Finish: Red alkyd-gloss enamel paint unless otherwise indicated.
11. Inlet: **NPS 2 (DN 50)** minimum.
12. Operating Wrench: One for each unit.

B. Flushing Hydrants - Ground Type: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GIL Industries, Inc**]
    b. [**Kupferle Foundry Co. (The)**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**GIL Industries, Inc**]
    b. [**Kupferle Foundry Co. (The)**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain flushing hydrants - ground type, from single manufacturer.
4. Pressure Rating: **150 psig (1035 kPa)** minimum.
5. Outlet: One, with [**vertical**][**angle**] discharge.
6. Hose Thread: **NPS 2-1/2 (DN 65)**, with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
7. Barrel: Cast-iron or steel pipe.
8. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
9. Inlet: **NPS 2 (DN 50)** minimum.
10. Hydrant Box: Cast iron with cover, for ground mounting.
11. Operating Wrench: One for each unit.

2.28 SAMPLING STATIONS

A. Sampling Station - Post Type: Nonfreeze and drainable, of length required for shutoff valve installation

below frost line.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GIL Industries, Inc**]
    b. [**Kupferle Foundry Co. (The)**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**GIL Industries, Inc**]
    b. [**Kupferle Foundry Co. (The)**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain sampling stations - post type, from single manufacturer.
4. Pressure Rating: **100 psig (690 kPa)** minimum.
5. Sampling Outlet: One unthreaded nozzle with handle.
6. Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
7. Drain: Tubing with separate manual vacuum pump.
8. Inlet: **NPS 3/4 (DN 20)** minimum.
9. Housing: Weatherproof material with locking device. Include anchor device.
10. Operating Wrench: One for each unit.

2.29 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Croker; a Division of Morris Group International**]
    b. [**Elkhart Brass Mfg. Co., Inc**]
    c. [**Guardian Fire Equipment, Inc**]
    d. [**Kidde; Carrier Global Corporation**]
    e. [**Potter Roemer LLC; a Division of Morris Group International**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Croker; a Division of Morris Group International**]
    b. [**Elkhart Brass Mfg. Co., Inc**]
    c. [**Guardian Fire Equipment, Inc**]
    d. [**Kidde; Carrier Global Corporation**]
    e. [**Potter Roemer LLC; a Division of Morris Group International**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fire department connections from single manufacturer.
4. Standard: UL 405.
5. Configuration: Freestanding, with cast-bronze body, thread inlets in accordance with NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; **18-inch- (460-mm-)** high, brass sleeve; and round escutcheon plate.
6. Connections:

    a. [**Two**][**Three**] **NPS 2-1/2 (DN 65)** inlets and one [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**] outlet.
    b. Two **NPS 3 (DN 80)** inlets and one [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**] outlet.
    c. [**Three**][**Four**] **NPS 2-1/2 (DN 65)** inlets and one **NPS 6 (DN 150)** outlet.
    d. Six **NPS 2-1/2 (DN 65)** inlets and one [**NPS 6 (DN 150)**][**NPS 8 (DN 200)**] outlet.

7. Inlet Alignment: [**Inline, horizontal**][**Square**].
8. Finish Including Sleeve: [**Polished chrome-plated**][**Rough chrome-plated**][**Polished bronze**].
9. Escutcheon Plate Marking: "[**AUTO SPKR**][**&**][**STANDPIPE**]."

2.30 ALARM DEVICES

A. Alarm Devices: UL 753 and FM Global approved, of types and sizes to mate and match piping and equipment.

B. Water-Flow Indicators: Vane-type water-flow detector, rated for **250 psig (1725 kPa)** working pressure; designed for horizontal or vertical installation; with 2 SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.

C. Supervisory Switches: SPDT; designed to signal valve in other than fully open position.

D. Pressure Switches: SPDT; designed to signal increase in pressure.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.2 PIPING APPLICATIONS

A. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.

B. Do not use flanges or unions for underground piping.

C. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

D. Underground water-service piping [**NPS 3/4 to NPS 3 (DN 20 to DN 80)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Soft copper tube, [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**]; [**wrought-copper, solder-joint fittings; and brazed**][**copper, pressure-seal fittings; and pressure-sealed**] joints.
2. PE, ASTM pipe; [**insert fittings for PE pipe; and clamped**][**molded PE fittings; and heat-fusion**] joints.
3. PVC, Schedule [**40 pipe; PVC, Schedule 40**][**80 pipe; PVC, Schedule 80**] socket fittings; and solvent-cemented joints.
4. **NPS 1 to NPS 3 (DN 25 to DN 80)** fiberglass, RTRP, AWWA pipe, [**Class 150**][**Class 200**][**Class 250**]; RTRF, AWWA pipe; and bonded joints.
5. Fiberglass, RTRP, AWWA pipe [**Class 150**][**Class 200**][**Class 250**]; RTRF; and bonded joints.

E. Underground water-service piping [**NPS 4 to NPS 8 (DN 100 to DN 200)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Soft copper tube, [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**]; wrought-copper, solder-joint fittings; and brazed joints.
2. Ductile-iron, [**push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed**][**mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical**][**grooved-end pipe; ductile-iron-pipe appurtenances; and grooved**] joints.
3. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
4. PVC, Schedule [**40 pipe; PVC, Schedule 40**][**80 pipe; PVC, Schedule 80**] socket fittings; and solvent-cemented joints.
5. NPS 4 and NPS 6 (DN 100 and DN 150): **NPS 6 (DN 150)** PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 [**fabricated**][**or**][**molded**] fittings; and gasketed joints.
6. NPS 8 (DN 200): PVC, AWWA Class 200 pipe; [**PVC, AWWA Class 200 fabricated**][**push-on-joint, ductile-iron**][**mechanical-joint, ductile-iron**] fittings; and gasketed joints.
7. Fiberglass, RTRP, AWWA pipe [**Class 150**][**Class 200**][**Class 250**]; RTRF, AWWA pipe; and bonded joints.

F. Water Meter Box Water-Service Piping: [**NPS 3/4 to NPS 2 (DN 20 to DN 50)**]<**Insert pipe size range**> to be same as underground water-service piping.

G. Aboveground[**and vault**] water-service piping [**NPS 3/4 to NPS 3 (DN 20 to DN 80)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Hard copper tube, [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**]; [**wrought-copper, solder-joint fittings; and brazed**][**copper, pressure-seal fittings; and pressure-sealed**] joints.
2. PVC, Schedule 80 pipe; PVC, Schedule 80 [**socket fittings; and solvent-cemented**][**threaded fittings; and threaded**] joints.
3. **NPS 1 to NPS 2 (DN 25 to DN 50)** fiberglass, RTRP, AWWA pipe [**Class 150**][**Class 200**][**Class 250**]; RTRF, AWWA pipe; and bonded joints.

H. Aboveground [**and vault**]water-service piping [**NPS 4 to NPS 8 (DN 100 to DN 200)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Hard copper tube, [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**]; wrought-copper, solder-joint fittings; and brazed joints.
2. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
3. PVC, Schedule 80 pipe; PVC, Schedule 80 [**socket fittings; and solvent-cemented**][**threaded fittings; and threaded**] joints.
4. Fiberglass, RTRP, AWWA pipe [**Class 150**][**Class 200**][**Class 250**]; RTRF, AWWA pipe; and bonded joints.

I. Underground fire-service-main piping [**NPS 4 to NPS 12 (DN 100 to DN 300)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Ductile-iron, [**push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed**][**mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical**][**grooved-end pipe; ductile-iron-pipe appurtenances; and grooved**] joints.
2. PE, [**Class 150**][**Class 200**], fire-service pipe; molded PE fittings; and heat-fusion joints.
3. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
4. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
5. Fiberglass, AWWA, FM Global approved RTRP, [**Class 150**][**Class 200**]; RTRF; and gasketed joints.

J. Aboveground[**and vault**] fire-service-main piping [**NPS 4 to NPS 12 (DN 100 to DN 300)**]<**Insert pipe size range**> to be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

K. Underground Combined Water-Service and Fire-Service-Main Piping [**NPS 6 to NPS 12 (DN 150 to DN 300)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Ductile-iron, [**push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed**][**mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical**][**grooved-end pipe; ductile-iron-pipe appurtenances; and grooved**] joints.
2. PVC, AWWA [**Class 150**][**Class 200**] pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
3. Fiberglass, AWWA, FM Global approved RTRP, [**Class 150**][**Class 200**]; RTRF; and gasketed joints.

L. Aboveground[**and vault**] combined water service and fire-service-main piping [**NPS 6 to NPS 12 (DN 150 to DN 300)**]<**Insert pipe size range**> to be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for **NPS 3 (DN 80)** and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM Global, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for **NPS 2 (DN 50)** and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, [**metal**][**resilient**][**high-pressure, resilient**]-seated gate valves with valve box.
2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FM Global, cast-iron, nonrising-stem gate valves with indicator post.
3. Use the following for valves in vaults and aboveground:

    a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, [**nonrising**][**rising**] stem.
    b. Gate Valves, NPS 3 (DN 80) and Larger: [**AWWA, cast iron, OS&Y rising stem, metal seated**][**AWWA, cast iron, OS&Y rising stem, resilient seated**][**UL/FM Global, cast iron, OS&Y rising stem**].
    c. Check Valves: [**AWWA C508**][**UL/FM Global**], swing type.

4. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
5. Relief Valves: Use for water-service piping in vaults and aboveground.

a. Air-Release Valves: To release accumulated air.
b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
c. Combination Air Valves: To release or admit air.

6. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Comply with Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

B. Provide a continuous bare copper or aluminum tracer wire not less than **0.10 inch (2.5 mm)** in diameter in sufficient length over each separate run of nonmetallic pipe.

3.5 INSTALLATION OF PIPING

A. Water-Main Connection:

1. Arrange with utility company for tap of size and in location indicated in water main.
2. Tap water main in accordance with requirements of water utility company and of size and in location indicated.

B. Make connections larger than **NPS 2 (DN 50)** with tapping machine according to the following:

1. Install tapping sleeve and tapping valve in accordance with MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections **NPS 2 (DN 50)** and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

1. Install PE corrosion-protection encasement in accordance with ASTM A674 or AWWA C105/A21.5.
2. Install copper tube and fittings in accordance with CDA's "Copper Tube Handbook."

E. Install ductile-iron, water-service piping in accordance with AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement in accordance with ASTM A674 or AWWA

C105/A21.5.

F. Install PE pipe in accordance with ASTM D2774 and ASTM F645.

G. Install PVC, AWWA pipe in accordance with ASTM F645 and AWWA M23.

H. Install fiberglass AWWA pipe in accordance with AWWA M45.

I. Bury piping with depth of cover over top at least [**30 inches (750 mm)**]<**Insert dimension**>, with top at least [**12 inches (300 mm)**]<**Insert dimension**> below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least [**36 inches (910 mm)**]<**Insert dimension**> of cover over top.
2. Under Railroad Tracks: With at least [**48 inches (1220 mm)**]<**Insert dimension**> of cover over top.
3. In Loose Gravelly Soil and Rock: With at least [**12 inches (300 mm)**]<**Insert dimension**> of additional cover.

J. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

K. Extend [**water-service**][**and**][**fire-suppression water-service**] piping and connect to water-supply source and building [**water-piping**][**and**][**fire-suppression piping**] systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate [**water-service**][**and**][**fire-suppression water-service**] piping at building wall until building [**water-piping**][**and**][**fire-suppression piping**] systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building [**water-piping**][**and**][**fire-suppression piping**] systems when those systems are installed.

L. Sleeves are specified in [**Section 210500 "Common Work Results for Fire Suppression"**][**and**][**Section 220500 "Common Work Results for Plumbing."**]

M. Mechanical sleeve seals are specified in [**Section 210500 "Common Work Results for Fire Suppression"**][**and**][**Section 220500 "Common Work Results for Plumbing."**]

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in [**Section 210500 "Common Work Results for Fire Suppression"**][**and**][**Section 220500 "Common Work Results for Plumbing."**]

O. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

P. Comply with Section 211000 "Water-Based Fire-Suppression Systems" for fire-suppression-water piping inside the building.

Q. Comply with Section 221116 "Domestic Water Piping" for potable-water piping inside the building.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in [**Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment"**][**and**][**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**]

B. Comply with requirements for hangers, supports, and anchor devices specified in [**Section 210529 "Hangers and Supports for Fire-Suppression Piping and Equipment"**][**and**][**Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."**]

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than **20 ft. (6 m)** long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping **20 ft. (6 m)** or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft. (6 m)** or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On [**PVC**][**and**][**fiberglass**] piping, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for copper tubing with maximum spacing and minimum rod diameters to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install hangers for PVC piping with maximum horizontal spacing and minimum rod diameters to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Install hangers for fiberglass piping with maximum horizontal spacing and minimum rod diameters to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting and coupling.

H. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

I. Support vertical runs of [**PVC**][**fiberglass**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 JOINT CONSTRUCTION

A. Comply with Section 330500 "Common Work Results for Utilities" for basic piping joint construction.

B. Make pipe joints according to the following:

1. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools and procedures recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts in accordance with coupling manufacturer's written instructions.
5. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners in accordance with fitting manufacturer's written instructions.
6. PVC Piping Gasketed Joints: Use joining materials in accordance with AWWA C900. Construct joints with elastomeric seals and lubricant in accordance with ASTM D2774 or ASTM D3139 and pipe manufacturer's written instructions.

7. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
8. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

    a. Dielectric Fittings:

        1) Dielectric [**nipples**][**unions**] for [**NPS 2 (DN 50)**]<**Insert pipe size**> and smaller.
        2) Dielectric [**flanges**][**flange kits**][**nipples**] for [**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**]<**Insert pipe size range**>.
        3) Dielectric flange kits for [**NPS 5 (DN 125)**]<**Insert pipe size**> and Larger.

3.8 INSTALLATION OF ANCHORAGE

A. Anchorage: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.
7. <**Insert devices**>.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: In accordance with AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: In accordance with AWWA M23.
3. Bonded-Joint Fiberglass, Water-Service Piping: In accordance with AWWA M45.
4. Fire-Service-Main Piping: In accordance with NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.9 INSTALLATION OF VALVES

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves.[**Install full-size valved bypass.**]

H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

I. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete" for support of valves and piping not direct buried.

3.10 INSTALLATION OF DETECTOR-CHECK VALVES

A. Install in vault or aboveground.

B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers. Comply with requirements of concrete piers in Section 033000 "Cast-in-Place Concrete."

3.11 INSTALLATION OF WATER METERS

A. Install water meters, piping, and specialties in accordance with utility company's written instructions.

B. Water Meters:

1. Install [**displacement**][**turbine**]-type water meters, **NPS 2 (DN 50)** and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
2. Install [**compound**][**turbine**]-type water meters, **NPS 3 (DN 80)** and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
3. Install detector-type water meters in meter vault in accordance with AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

C. Support water meters and piping **NPS 3 (DN 80)** and larger on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.12 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation in accordance with utility company's written instructions.

3.13 INSTALLATION OF VACUUM BREAKER ASSEMBLIES

A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.14 INSTALLATION OF BACKFLOW PREVENTERS

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support **NPS 2-1/2 (DN 65)** and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.15 INSTALLATION OF WATER METER BOXES

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top [**2 inches (50 mm)**]<**Insert dimension**> above surface.

3.16 INSTALLATION OF CONCRETE VAULTS

A. Install precast concrete vaults in accordance with ASTM C891.

3.17 INSTALLATION OF PROTECTIVE ENCLOSURES

A. Install concrete base level and with top approximately [**2 inches (50 mm)**]<**Insert measurement**> above grade.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.18 INSTALLATION OF FIRE HYDRANTS

A. Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

D. UL/FM Global Fire Hydrants: Comply with NFPA 24.

3.19 INSTALLATION OF FLUSHING HYDRANTS

A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.

B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant

box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.

C. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

3.20 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

A. Install ball drip valves at each check valve for fire department connection to mains.

B. Install protective pipe bollards [**on two sides of**][**on three sides of**]<**Insert arrangement**> each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.21 INSTALLATION OF ALARM DEVICES

A. Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.

B. Supervisory Switches: Supervise valves in open position.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.
2. Post Indicators: Install padlock on wrench on indicator post.

D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

F. Connect alarm devices to building fire-alarm system. Wiring and fire-alarm devices are specified in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

3.22 CONNECTIONS

A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to [**utility water main**][**existing water main**]<**Insert piping system**>. Use [**tapping sleeve and tapping valve**][**service clamp and corporation valve**]<**Insert method**>.

C. Connect water-distribution piping to interior [**domestic water**][**and**][**fire-suppression**] piping.

D. Connect waste piping from concrete vault drains to [**sanitary sewerage system. See Section 333115 "Site Sanitary Sewerage Piping" for connection to sanitary-sewer**][**storm-drainage system. See Section 334400 "Storm Utility Drainage Piping" for connection to storm-sewer**] piping.

E. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.23 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in **50 psig (350 kPa)** increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to **0 psig (0 kPa)**. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is **2 quarts (1.89 L)** per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.24 IDENTIFICATION

A. Install continuous underground[**detectable**] warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

3.25 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for three hours.
c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure

if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 33 14 00 00

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Task	Specification	Specification Description
33 14 11 00	33 14 00 00	Site Water Distribution Piping
33 14 13 00	33 14 00 00	Site Water Distribution Piping
33 14 13 13	31 62 23 00	Composite Piles
33 14 13 13	33 14 00 00	Site Water Distribution Piping
33 14 13 13	33 42 00 00	Stormwater Conveyance
33 14 13 23	33 14 00 00	Site Water Distribution Piping
33 14 13 23	33 42 00 00	Stormwater Conveyance
33 14 13 23	33 46 00 00	Subdrainage
33 14 13 26	33 14 00 00	Site Water Distribution Piping
33 14 13 36	33 14 00 00	Site Water Distribution Piping
33 14 13 39	33 14 00 00	Site Water Distribution Piping
33 14 13 43	33 14 00 00	Site Water Distribution Piping
33 14 13 53	07 63 00 00	Common Work Results for Fire Suppression
33 14 13 53	22 05 00 00	Common Work Results for Plumbing
33 14 13 53	22 11 16 00	Domestic Water Piping
33 14 13 53	22 13 16 00	Sanitary Waste And Vent Piping
33 14 13 53	22 14 13 00	Storm Drainage Piping
33 14 13 53	22 11 16 00a	General-Service Compressed-Air Piping
33 14 13 53	07 63 00 00a	Common Work Results for HVAC
33 14 13 53	22 11 16 00c	Hydronic Piping
33 14 13 53	22 11 16 00d	Steam And Condensate Piping
33 14 13 53	22 11 16 00e	Refrigerant Piping
33 14 13 53	33 14 00 00	Site Water Distribution Piping
33 14 19 00	22 05 23 00	General-Duty Valves for Plumbing Piping
33 14 19 00	22 05 23 00a	General-Duty Valves for HVAC Piping
33 14 19 00	33 14 00 00	Site Water Distribution Piping
33 14 23 00	33 14 00 00	Site Water Distribution Piping

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SECTION 33 31 00 00 - SITE SANITARY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-iron soil pipe and fittings - hub and spigot.
2. Cast-iron soil pipe and fittings - hubless.
3. Ductile-iron, pressure pipe and fittings.
4. ABS pipe and fittings.
5. PVC pipe and fittings.
6. Fiberglass sewer pipe and fittings.
7. Concrete pipe and fittings.
8. Nonpressure-type transition couplings.
9. Pressure-type pipe couplings.
10. Expansion joints and deflection fittings.
11. Encasement for piping.
12. Manholes.
13. Concrete.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans and elevations, or Building Information Model (BIM), drawn to scale, showing items described in this Section and coordinated with all building trades. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than **1 inch equals 50 ft. (1:50)** and to vertical scale of not less than **1 inch equals 5 ft. (1:50)**. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes in accordance with manufacturer's written rigging instructions.

1.6 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.7 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Sanitary Sewage Piping: [**10-ft. head of water (30 kPa)**]<**Insert pressure**>.
2. Sanitary Sewage Piping, Force-Main: [**50 psig (345 kPa)**][**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**>.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]

2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain cast-iron, hub-and-spigot pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Class:[**Service (SV)**][**and**][**Extra-Heavy (XH)**]; ASTM A74.

E. Gaskets: ASTM C564, rubber.

F. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain cast-iron, hubless pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standards: ASTM A888 or CISPI 301.

E. Shielded Couplings, CISPI-Trademark:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**Dallas Specialty & Mfg. Co.**]
d. [**Fernco Inc**]
e. [**Mission Rubber Company, LLC**]
f. [**Tyler Pipe; a part of the McWane family of companies**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Mission Rubber Company, LLC**]
    f. [**Tyler Pipe; a part of the McWane family of companies**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain CISPI-trademark, shielded couplings from single manufacturer.
4. Marked with CISPI collective trademark and NSF certification mark.
5. Standards: ASTM C1277 and CISPI 310.
6. Description: Stainless steel corrugated shield; stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Shielded Couplings, Heavy-Duty:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Mission Rubber Company, LLC**]
    f. [**Tyler Pipe; a part of the McWane family of companies**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Mission Rubber Company, LLC**]
    f. [**Tyler Pipe; a part of the McWane family of companies**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain heavy-duty, shielded couplings from single manufacturer.
4. Standard: ASTM C1540.
5. Description: Stainless steel shield; stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

G. Shielded Couplings, Cast-Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**MG Coupling**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MG Coupling**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron, shielded couplings from single manufacturer.
4. Standard: ASTM A1056.
5. Description: Two-piece, ASTM A48/A48M, cast-iron housing; stainless steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

H. Unshielded Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain unshielded couplings from single manufacturer.
4. Standard: ASTM C1461.
5. Description: Rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.4 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS - SANITARY SEWERAGE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Cast Iron Pipe Company**]
2. [**McWane Ductile; a part of the McWane family of companies**]
3. [**U.S. Pipe**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Cast Iron Pipe Company**]

2. [**McWane Ductile; a part of the McWane family of companies**]
3. [**U.S. Pipe**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain ductile-iron, pressure pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Push-on-Joint Piping:

1. Pipe: AWWA C151/A21.51.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron.
3. Compact Fittings: AWWA C153/A21.53.
4. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe and fittings.

F. Mechanical-Joint Piping:

1. Pipe: AWWA C151/A21.51, with bolt holes in bell.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with bolt holes in bell.
3. Compact Fittings: AWWA C153/A21.53, with bolt holes in bells.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe, fittings, and glands.

G. Pipe Outer Coating:

1. Type: Asphaltic.
2. Minimum Uniform Thickness: [**1 mil (0.025 mm)**]<**Insert thickness**>.
3. Comply with AWWA C151/A21.51.

H. Cement Mortar Lining: AWWA C104/A21.4.

I. Seal Coating-Applied Lining:

1. Nominal Pipe Sizes 6 through 12 Inches (150 through 300 mm): **1/8 inch (3 mm)**.
2. Nominal Pipe Sizes 14 through 24 Inches (250 through 600 mm): <**Insert inches (mm)**>.

J. Asphaltic Sealcoat Lining:

1. Minimum Uniform Lining: [**1 mil (0.025 mm)**]<**Insert thickness**>.
2. Comply with AWWA C104/A21.4.

K. PE Encasement: Comply with AWWA C105/A21.5.

L. Coating:

1. Coat pipe and fittings exposed inside of structures with two coats of <**Insert paint type and paint code**> bituminous paint to achieve minimum dry film of thickness of <**Insert mils (mm)**> per coat.

2.5 ABS PIPE AND FITTINGS

A. Source Limitations: Obtain ABS pipe and fittings from single manufacturer.

B. Piping materials to bear label, stamp, or other markings of specified testing agency.

C. ABS Solid-Wall Pipe: ASTM D2661, Schedule 40.

1. Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.
2. Joints: ASTM D2235, solvent weld.

D. ABS Cellular-Core Pipe: ASTM F628, Schedule 40.

1. Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.
2. Joints: ASTM D2235, solvent weld.

E. ABS Pipe and Fittings: SDR [**23.5**][**35**][**42**] with bell-and-spigot-style, solvent-sealed ends.

1. Joints: ASTM D2235, solvent weld.

F. Solvent Cement: ASTM D2235.

2.6 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**JM Eagle**]
4. [**National Pipe and Plastic, Inc. (Oldcastle)**]
5. [**Silver-line Plastics**]
6. [**Westlake Pipe & Fittings**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**JM Eagle**]
4. [**National Pipe and Plastic, Inc. (Oldcastle)**]
5. [**Silver-line Plastics**]
6. [**Westlake Pipe & Fittings**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. PVC Type PSM Gravity Sewer Piping:

1. Pipe: ASTM D3034, [**SDR 35**]<**Insert SDR**>, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

F. PVC Pressure Piping:

1. Pipe: AWWA C900, [**Class 100**][**Class 150**][**and**][**Class 200**] PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, [**Class 100**][**Class 150**][**and**][**Class 200**] PVC pipe with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

G. PVC Type DWV Piping:

1. Pipe: ASTM D1785 or ASTM D2665, [**Schedule 40**][**and**][**Schedule 80**] PVC, with plain ends for solvent-cemented joints.
2. Fittings: [**ASTM D2466, Schedule 40**][**and**][**ASTM D2467, Schedule 80**] PVC, socket type.
3. Adhesive Primer: ASTM F656.
4. Solvent Cement: ASTM D2564.

2.7 FIBERGLASS SEWER PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Augusta Fiberglass**]
2. [**Industrial Fiberglass Specialties, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Augusta Fiberglass**]
2. [**Industrial Fiberglass Specialties, Inc.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain fiberglass sewer pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Fiberglass Sewer Pipe: ASTM D3262, RTRP, for gasketed joints fabricated with [**Type 2, polyester**][**or**][**Type 4, epoxy**] resin.

1. Liner: [**Reinforced thermoset**][**Nonreinforced thermoset**][**Thermoplastic**][**No liner**].
2. Grade: [**Reinforced, surface layer matching pipe resin**][**Nonreinforced, surface layer matching pipe resin**][**No surface layer**]<**Insert grade**>.
3. Stiffness: [**9 psig (62 kPa)**][**18 psig (124 kPa)**][**36 psig (248 kPa)**][**72 psig (496 kPa)**]

F. Fiberglass Nonpressure Fittings: ASTM D3840, RTRF, for gasketed joints.

1. Laminating Resin: [**Type 1, polyester**][**or**][**Type 2, epoxy**] resin.
2. Reinforcement: Grade with finish compatible with resin.

G. Gaskets: ASTM F477, elastomeric seals.

2.8 CONCRETE PIPE AND FITTINGS - SANITARY SEWERAGE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Northern Concrete Pipe, Inc.**]
2. [**Rinker Materials Corporation, Concrete Pipe Division**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Northern Concrete Pipe, Inc.**]
2. [**Rinker Materials Corporation, Concrete Pipe Division**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Nonreinforced-Concrete Sewer Pipe and Fittings: **ASTM C14 (ASTM C14M)**, [**Class 1**][**Class 2**][**Class 3**], with [**bell-and-spigot**][**or**][**tongue-and-groove**] ends for gasketed joints with **ASTM C443 (ASTM C443M)**, rubber gaskets.

F. Reinforced-Concrete Sewer Pipe and Fittings: **ASTM C76 (ASTM C76M)**.

1. [**Bell-and-spigot**][**or**][**tongue-and-groove**] ends for gasketed joints, with **ASTM C443 (ASTM C443M)**, rubber gaskets.
2. Class II, [**Wall A**][**Wall B**][**Wall C**].
3. Class III, [**Wall A**][**Wall B**][**Wall C**].
4. Class IV, [**Wall A**][**Wall B**][**Wall C**].
5. Class V, [**Wall A**][**Wall B**].

2.9 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
2. For Concrete Pipes: **ASTM C443 (ASTM C443M)**, rubber.
3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dallas Specialty & Mfg. Co.**]
b. [**Fernco Inc**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dallas Specialty & Mfg. Co.**]
b. [**Fernco Inc**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain unshielded, flexible couplings from single manufacturer.
4. Description: Elastomeric sleeve with[**stainless steel shear ring and**] corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dallas Specialty & Mfg. Co.**]
b. [**Mission Rubber Company, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dallas Specialty & Mfg. Co.**]
b. [**Mission Rubber Company, LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain shielded, flexible couplings from single manufacturer.
4. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fernco Inc**]
b. [**Mission Rubber Company, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fernco Inc**]
b. [**Mission Rubber Company, LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ring-type, flexible couplings from single manufacturer.
4. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain nonpressure-type, rigid couplings from single manufacturer.
4. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.10 PRESSURE-TYPE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cascade Waterworks Mfg. Co.**]
2. [**Dresser Utility Solutions**]
3. [**Ford Meter Box Company, Inc. (The)**]
4. [**JCM Industries, Inc**]
5. [**Romac Industries, Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Cascade Waterworks Mfg. Co.**]
2. [**Dresser Utility Solutions**]
3. [**Ford Meter Box Company, Inc. (The)**]
4. [**JCM Industries, Inc**]
5. [**Romac Industries, Inc.**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pressure-type pipe couplings from single manufacturer.

D. Standard: AWWA C219.

E. Description: Tubular-sleeve coupling with center sleeve, gaskets, end rings, and bolt fasteners.

F. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include [**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> minimum pressure rating and ends of same sizes as piping to be joined.

G. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].

H. Gasket Material: Natural or synthetic rubber.

I. Metal Component Finish: Corrosion-resistant coating or material.

2.11 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**EBAA Iron Sales, Inc.**]
    b. [**Romac Industries, Inc.**]
    c. [**Star Pipe Products**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**EBAA Iron Sales, Inc.**]
    b. [**Romac Industries, Inc.**]
    c. [**Star Pipe Products**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron, flexible expansion joints from single manufacturer.
4. Standards:

    a. AWWA C110/A21.10.
    b. AWWA C153/A21.53.

5. Description: Compound fitting with combination of flanged and mechanical-joint ends. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for **250 psig (1725 kPa)** minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Deflection Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**EBAA Iron Sales, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EBAA Iron Sales, Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
4. Standards:

a. AWWA C110/A21.10.
b. AWWA C153/A21.53.

5. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends. Include rating for **250 psig (1725 kPa)** minimum working pressure and for up to 15 degrees of deflection.

2.12 ENCASEMENT FOR PIPING

A. Standards: ASTM A674 or AWWA C105/A21.5.

B. Material: [**Linear low-density polyethylene film of 0.008-inch (0.20-mm)**][**or**][**high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)**] minimum thickness.

C. Form: [**Sheet**][**or**][**tube**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

2.13 MANHOLES

A. Standard Precast Concrete Manholes:

1. Standard: ASTM C478/C478M.
2. Description: Precast, reinforced concrete, of depth indicated, with provision for sealant joints.
3. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
4. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
5. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (100-mm)** minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
6. Riser Sections: **4-inch (100-mm)** minimum thickness, of length to provide depth indicated.
7. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
8. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
9. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
10. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in**

ASTM D4101, PP]<**Insert material**>; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.

11. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
12. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Standards: ASTM C913 and ASTM C890.
2. Description: Designed in accordance with ASTM C890 for A-16 designation, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
3. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
4. Joint Sealant: **ASTM C990 (ASTM 990M)**, bitumen or butyl rubber.
5. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
6. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
7. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
8. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

C. Fiberglass Manholes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Associated Fiberglass Enterprises**]
    b. [**Containment Solutions, Inc**]
    c. [**L. F. Manufacturing, Inc**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Associated Fiberglass Enterprises**]
    b. [**Containment Solutions, Inc**]

c. [**L. F. Manufacturing, Inc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain FRP manholes from single manufacturer.
4. Standard: ASTM D3753.
5. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
6. Ballast: Increase thickness of concrete base as required to prevent flotation.
7. Base Section: Concrete, **6-inch (150-mm)** minimum thickness.
8. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

D. Manhole Frames and Covers:

1. Description: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser, with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: [**ASTM A536, Grade 60-40-18 ductile**][**ASTM A48/A48M, Class 35 gray**] iron unless otherwise indicated.

E. Manhole-Cover Inserts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**L. F. Manufacturing, Inc**]
   b. [**Vortex Companies**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**L. F. Manufacturing, Inc**]
   b. [**Vortex Companies**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain manhole-cover inserts from single manufacturer.
4. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
5. Type: [**Solid**][**Drainage with vent holes**][**Valve**].

2.14 CONCRETE

A. Description: Cast-in-place concrete complying with ACI 318, **ACI 350 (ACI 350M)**, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (420-MPa)** deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: [**1**][**2**] percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: [**4**][**8**] percent.

D. Ballast and Pipe Supports: Portland cement design mix, **3000 psi (20.7 MPa)** minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (420 MPa)** deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for using lubricants, cements, and other installation

requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping in accordance with the following:

1. Install piping pitched down in direction of flow, at minimum slope of [**1**][**2**]<**Insert number**> percent unless otherwise indicated.
2. Install piping [**NPS 6 (DN 150)**]<**Insert pipe size**> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with [**36-inch (915-mm)**][**48-inch (1220-mm)**][**60-inch (1520-mm)**][**72-inch (1830-mm)**]<**Insert dimension**> minimum cover.
4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ABS sewer piping in accordance with ASTM D2321 and ASTM F1668.
7. Install PVC Type PSM sewer piping in accordance with ASTM D2321 and ASTM F1668.
8. Install PVC Type DWV gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
9. Install fiberglass sewer piping in accordance with ASTM D3839 and ASTM F1668.
10. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479/C1479M and ACPA's "Concrete Pipe & Box Culvert Installation Manual."
11. Install reinforced-concrete sewer piping in accordance with ASTM C1479/C1479M and ACPA's "Concrete Pipe & Box Culvert Installation Manual."

G. Install force-main, pressure piping in accordance with the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with [**36-inch (915-mm)**][**48-inch (1220-mm)**][**60-inch (1520-mm)**][**72-inch (1830-mm)**]<**Insert dimension**> minimum cover.
3. Install ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41.
4. Install ductile-iron special fittings in accordance with AWWA C600.
5. Install PVC pressure piping in accordance with AWWA M23 or to ASTM D2774 and ASTM F1668.

H. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping in accordance with the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.
3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ABS sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
5. Join PVC Type PSM sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
6. Join fiberglass sewer piping in accordance with ASTM D4161 for elastomeric-seal joints.
7. Join nonreinforced-concrete sewer piping in accordance with **ASTM C14 (ASTM C14M)** and ACPA's "Concrete Pipe & Box Culvert Installation Manual" for rubber-gasket joints.
8. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe & Box Culvert Installation Manual" for rubber-gasket joints.
9. Join dissimilar pipe materials with nonpressure-type, flexible[**or rigid**] couplings.

B. Join force-main, pressure piping in accordance with the following:

1. Join ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings in accordance with AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping in accordance with AWWA M23 for gasketed joints.
4. Join dissimilar pipe materials with pressure-type couplings.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

    a. [**Unshielded**][**Shielded**] flexible[**or rigid**]couplings for pipes of same or slightly different OD.
    b. Unshielded, increaser/reducer-pattern, flexible[**or rigid**]couplings for pipes with different OD.
    c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure pipe couplings for force-main joints.

3.4 INSTALLATION OF MANHOLES

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.

C. Install FRP manholes in accordance with manufacturer's written instructions.

D. Form continuous concrete channels and benches between inlets and outlet.

E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [3 inches (76 mm)]<**Insert dimension**> above finished surface elsewhere unless otherwise indicated.

F. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete in accordance with ACI 318.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to [**grease**][**oil**][**and**][**sand**] interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least [**8-inch- (203-mm-)**]<**Insert dimension**> thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least [**36 inches (915 mm)**]<**Insert dimension**> below final grade. Fill to within [**12 inches (300 mm)**]<**Insert dimension**> of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.8 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use[**warning tape or**] detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches (600 mm)** of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage in accordance with requirements of authorities having jurisdiction and the following:

a. Fill sewer piping with water. Test with pressure of at least **10-ft. (3-m)** head of water, and maintain such pressure without leakage for at least 15 minutes.
b. Close openings in system and fill with water.
c. Purge air and refill with water.
d. Disconnect water supply.
e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Test plastic gravity sewer piping in accordance with ASTM F1417.
b. Test concrete gravity sewer piping in accordance with ASTM C1628.

7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than one and one-half times the maximum system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert value**>.

a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.

8. Manholes: Perform hydraulic test in accordance with **ASTM C969 (ASTM C969M)**.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping.[**Flush with potable water.**]

END OF SECTION 33 31 00 00

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Task	Specification	Specification Description
33 31 11 00	33 31 00 00	Site Sanitary Sewerage Piping
33 31 11 00	33 42 00 00	Stormwater Conveyance
33 31 11 00	33 46 00 00	Subdrainage

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SECTION 33 32 00 00 - SITE PACKAGED SEWAGE PUMPING STATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged sewage pumping stations - dry well.
2. Packaged sewage pumping stations - wet well.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" for seismic-load, wind-load, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration and seismic controls.

1.2 PERFORMANCE REQUIREMENTS

A. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than **125 psig (860 kPa)**.

B. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Show fabrication and installation details for each packaged sewage pumping station.

1. Indicate layout at minimum scale of **1/2 inch per foot (1:25)**.
2. Detail pumping station assemblies and indicate dimensions.
3. Indicate size, materials, and components.
4. Indicate shipping, installed, and operating weights; loads; required clearances; method of field assembly; components.
5. Indicate basin size, inlet and discharge locations, cover dimensions, vent location, check valve and isolation valve locations.
6. Indicate electrical characteristics and junction box locations.
7. Indicate power, signal, and control wiring diagrams.
8. Signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of sewage pump, signed by product manufacturer.

B. Source quality-control test reports.

C. Field quality-control reports.

D. Qualification Statements: For [**Installer**][**testing agency**].

E. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For equipment.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

D. Comply with HI 14.1-14.2, HI 14.3, and HI 14.4.

E. Comply with UL 778.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of sanitary sewer service.
2. Do not proceed with interruption of sanitary sewer service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged sewage pumping stations that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including shell.
b. Faulty operation of sewage pumps, controls, or accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Shells: <**Insert number**> years from date of Substantial Completion.
3. Warranty Period for Sewage Pumps and Controls: <**Insert number**> years from date of Substantial Completion.
4. Warranty Period for Accessories: <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED SEWAGE PUMPING STATIONS - DRY WELL

A. Packaged Sewage Pumping Stations - Dry Well with Dry-Well Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dakota Pump Incorporated**]
   b. [**PumpTech, LLC**]
   c. [**Smith & Loveless**]
   d. [**USEMCO**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dakota Pump Incorporated**]
   b. [**PumpTech, LLC**]
   c. [**Smith & Loveless**]
   d. [**USEMCO**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain dry well with dry-well sewage pump, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for [**comminutor and**]collection of sanitary sewage and with dry equipment chamber for sewage pumps, controls, and accessories.

   a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
   b. Shell:

      1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

         a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
         b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
         c) Entrance Tube: From dry compartment to entrance at grade, and of size

required to replace largest piece of equipment, but not smaller than [36 inches (914 mm)]<**Insert dimension**> in diameter. Entrance tube walls are to be 1/4-inch (6.4-mm) minimum thickness.

d) Weld steel access ladder and air vent to shell[**and entrance tube**].
e) Apply three coats of epoxy resin to interior and exterior surfaces.
f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s) for cathodic protection.

2) Fabricate shell from fiberglass with structural-steel reinforcement.

a) Attach structural-steel reinforcement to top and bottom heads.
b) Fabricate shell with continuous joints to make watertight and gastight construction.
c) Attach air vent to pump chamber[**and entrance tube**].
d) Ladder: [**Steel**][**Fiberglass**].

3) Install sump, 18 inches (450 mm) in diameter by 10 inches (254 mm) deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4) Entrance tube may be furnished separately for field installation.
5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
7) Factory fabricate piping between unit components.

a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
b) Use fittings for changes in direction and branch connections.
c) Flanged and union joints may be used instead of joints specified.
d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

8) Piping Connections: Unless otherwise indicated, make the following piping connections:

a) Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having NPS 2 (DN 50) or smaller threaded pipe connection.
b) Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Comminutor: Full size of sewage inlet pipe.

1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
2) Body: Stainless steel or ductile iron with flanged ends and access plate.
3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
4) Motor: Explosion proof, directly connected to body.
5) Control Panel: [**NEMA 250, Type 12**]<**Insert designation**> enclosure for installation in dry equipment chamber.
6) <**Insert special control features**>.

d. Sewage Pumps: [**Two**][**Three**]<**Insert number**> dry-well-type, nonclog sewage pumps with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; mechanical or stuffing-box seals; and pedestal-mounted motor.

e. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

f. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.

2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

g. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Comminutor:

1) Capacity: <**Insert gpm (L/s)**>.
2) Pipe Size: <**Insert NPS (DN)**>.
3) Motor Size: <**Insert value**>.
4) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

f. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.

g. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller:

a) Type: <**Insert type**>.
b) Diameter: <**Insert inches (mm)**>.
c) Solids Size Design: <**Insert inches (mm)**>.

5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

9) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

7) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

B. Packaged Sewage Pumping Stations - Dry Well with Vacuum-Primed Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dakota Pump Incorporated**]
b. [**PumpTech, LLC**]
c. [**USEMCO**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dakota Pump Incorporated**]
b. [**PumpTech, LLC**]
c. [**USEMCO**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain dry well with vacuum-primed sewage pump, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for [**comminutor and**]collection of sanitary sewage and with dry equipment chamber for sewage pumps, vacuum pumps, controls, and accessories.

a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
b. Shell:

1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
d) Weld steel access ladder and air vent to shell[**and entrance tube**].
e) Apply three coats of epoxy resin to interior and exterior surfaces.
f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s) for cathodic protection.

2) Fabricate shell from fiberglass with structural-steel reinforcement.

a) Attach structural-steel reinforcement to top and bottom heads.
b) Fabricate shell with continuous joints to make watertight and gastight construction.
c) Attach air vent to pump chamber[**and entrance tube**].
d) Ladder: [**Steel**][**Fiberglass**].

3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4) Entrance tube may be furnished separately for field installation.
5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade,

outlet turned down, and with insect screen in outlet.

7) Factory fabricate piping between unit components.

   a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
   b) Use fittings for changes in direction and branch connections.
   c) Flanged and union joints may be used instead of joints specified.
   d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

8) Piping Connections: Unless otherwise indicated, make the following piping connections:

   a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
   b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

   a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
   b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
   c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
   d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Comminutor: Full size of sewage inlet pipe.

   1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
   2) Body: Stainless steel or ductile iron with flanged ends and access plate.
   3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
   4) Motor: Explosion proof, directly connected to body.
   5) Control Panel: NEMA 250, Type 12 enclosure for installation in dry equipment chamber.
   6) <**Insert special control features**>.

d. Sewage Pumps: [**Two**][**Three**]<**Insert number**> dry-chamber-mounting, vacuum-primed, nonclog sewage pumps located in dry compartment above wet pit, with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; mechanical or stuffing-box seals; pedestal-mounted motor; and suction piping extending to bottom of wet pit.

e. Vacuum Pumps: Duplex arrangement with controls, vacuum piping, and vent piping of size and capacity required for system. Include automatic alternator, with manual disconnect switch, to change sequence of lead-lag vacuum pumps at completion of each cycle.

f. Controls:

   1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel

if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.

2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

    a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
    b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

g. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

h. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Comminutor:

1) Capacity: <**Insert gpm (L/s)**>.
2) Pipe Size: <**Insert NPS (DN)**>.
3) Motor Size: <**Insert value**> hp.
4) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

f. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.
g. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller:

a) Type: <**Insert type**>.
b) Diameter: <**Insert inches (mm)**>.
c) Solids Size Design: <**Insert inches (mm)**>.

5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

9) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

7) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

2.2 PACKAGED SEWAGE PUMPING STATIONS - WET WELL

A. Packaged Sewage Pumping Stations - Wet Well with Submersible Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Metropolitan Industries, Inc**]
b. [**PumpTech, LLC**]
c. [**USEMCO**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Metropolitan Industries, Inc**]
b. [**PumpTech, LLC**]
c. [**USEMCO**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wet well with submersible sewage pumps, packaged sewage pumping

stations from single manufacturer.

4. Description: Factory fabricated, assembled, and tested with wet well for [**comminutor,**]submersible sewage pumps and collection of sanitary sewage and dry equipment chamber for controls and accessories.

   a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
   b. Shell:

      1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

         a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
         b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
         c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
         d) Weld steel access ladder and air vent to shell[**and entrance tube**].
         e) Apply three coats of epoxy resin to interior and exterior surfaces.
         f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s) for cathodic protection.

      2) Fabricate shell from fiberglass with structural-steel reinforcement.

         a) Attach structural-steel reinforcement to top and bottom heads.
         b) Fabricate shell with continuous joints to make watertight and gastight construction.
         c) Attach air vent to pump chamber[**and entrance tube**].
         d) Ladder: [**Steel**][**Fiberglass**].

      3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
      4) Entrance tube may be furnished separately for field installation.
      5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
      6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
      7) Factory fabricate piping between unit components.

         a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
         b) Use fittings for changes in direction and branch connections.
         c) Flanged and union joints may be used instead of joints specified.
         d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

      8) Piping Connections: Unless otherwise indicated, make the following piping connections:

         a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.

b) Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Comminutor: Full size of sewage inlet pipe.

1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
2) Body: Stainless steel or ductile iron with flanged ends and access plate.
3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
4) Motor: Explosion proof, directly connected to body.
5) Control Panel: NEMA 250, Type 12 enclosure for installation in dry equipment chamber.
6) <**Insert special control features**>.

d. Sewage Pumps: [**Two**][**Three**]<**Insert number**> submersible-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.

e. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on 6-inch (150-mm) minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and

covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

f. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

g. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Comminutor:

1) Capacity: <**Insert gpm (L/s)**>.
2) Pipe Size: <**Insert NPS (DN)**>.
3) Motor Size: <**Insert value**> hp.
4) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

f. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.
g. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller:

a) Type: <**Insert type**>.
b) Diameter: <**Insert inches (mm)**>.
c) Solids Size Design: <**Insert inches (mm)**>.

5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

9) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

7) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

B. Packaged Sewage Pumping Stations - Wet Well with Submersible Grinder Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Environment One Corporation**]
b. [**Metropolitan Industries, Inc**]
c. [**PumpTech, LLC**]
d. [**USEMCO**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Environment One Corporation**]
b. [**Metropolitan Industries, Inc**]
c. [**PumpTech, LLC**]
d. [**USEMCO**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wet well with submersible grinder sewage pumps, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for submersible grinder sewage pumps and collection of sanitary sewage and with dry equipment chamber for controls and accessories.

a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
b. Shell:

1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
d) Weld steel access ladder and air vent to shell[**and entrance tube**].
e) Apply three coats of epoxy resin to interior and exterior surfaces.
f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s)

for cathodic protection.

2) Fabricate shell from fiberglass with structural-steel reinforcement.

   a) Attach structural-steel reinforcement to top and bottom heads.
   b) Fabricate shell with continuous joints to make watertight and gastight construction.
   c) Attach air vent to pump chamber[**and entrance tube**].
   d) Ladder: [**Steel**][**Fiberglass**].

3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4) Entrance tube may be furnished separately for field installation.
5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
7) Factory fabricate piping between unit components.

   a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
   b) Use fittings for changes in direction and branch connections.
   c) Flanged and union joints may be used instead of joints specified.
   d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

8) Piping Connections: Unless otherwise indicated, make the following piping connections:

   a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
   b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

   a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
   b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
   c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
   d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Sewage Pumps: [**Two**][**Three**]<**Insert number**> submersible grinder-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.
d. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

    a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
    b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

e. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

f. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.
f. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller: [**Cutter**][**Cutter or grinder**][**Grinder**] type.
5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

9) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

g. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.

b) Phases: [**Single**][**Three**].
c) Hertz: 60.

7) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

C. Packaged Sewage Pumping Stations - Wet Well with Suspended Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dakota Pump Incorporated**]
b. [**PumpTech, LLC**]
c. [**Smith & Loveless**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dakota Pump Incorporated**]
b. [**PumpTech, LLC**]
c. [**Smith & Loveless**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wet well with suspended sewage pumps, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for [**comminutor,**]suspended sewage pumps and collection of sanitary sewage and with dry equipment chamber for pump motors, controls, and accessories.

a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
b. Shell:

1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.

d) Weld steel access ladder and air vent to shell[**and entrance tube**].
e) Apply three coats of epoxy resin to interior and exterior surfaces.
f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s) for cathodic protection.

2) Fabricate shell from fiberglass with structural-steel reinforcement.

a) Attach structural-steel reinforcement to top and bottom heads.
b) Fabricate shell with continuous joints to make watertight and gastight construction.
c) Attach air vent to pump chamber[**and entrance tube**].
d) Ladder: [**Steel**][**Fiberglass**].

3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4) Entrance tube may be furnished separately for field installation.
5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
7) Factory fabricate piping between unit components.

a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
b) Use fittings for changes in direction and branch connections.
c) Flanged and union joints may be used instead of joints specified.
d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

8) Piping Connections: Unless otherwise indicated, make the following piping connections:

a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Comminutor: Full size of sewage inlet pipe.

1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with

controls; for pipeline installation.
2) Body: Stainless steel or ductile iron with flanged ends and access plate.
3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
4) Motor: Explosion proof, directly connected to body.
5) Control Panel: [**NEMA 250, Type12**]<**Insert designation**> enclosure for installation in dry equipment chamber.
6) <**Insert special control features**>.

d. Sewage Pumps: [**Two**][**Three**]<**Insert number**> wet-well-mounting-type, nonclog sewage pumps suspended from dry-compartment floor, with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; grease-lubricated bearings and stuffing-box seal; shaft coupling; and pedestal-mounted motor.

e. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

f. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload

protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

g. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Comminutor:

1) Capacity: <**Insert gpm (L/s)**>.
2) Pipe Size: <**Insert NPS (DN)**>.
3) Motor Size: <**Insert value**> hp.
4) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

f. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.
g. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller:

    a) Type: <**Insert type**>.
    b) Diameter: <**Insert inches (mm)**>.
    c) Solids Size Design: <**Insert inches (mm)**>.

5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

    a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
    b) Phases: [**Single**][**Three**].
    c) Hertz: 60.

9) Motors:

    a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

    a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
    b) Phases: [**Single**][**Three**].
    c) Hertz: 60.

7) Motors:

    a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A6/A6M, W or HP shapes, or ASTM A36/A36M, plates or beams.

B. Grout: ASTM C1107/C1107M, Grade B, nonshrink cement grout.

1. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.

C. Concrete: Specified in Section 033000 "Cast-in-Place Concrete."

2.4 SOURCE QUALITY CONTROL

A. Test and inspect sewage[**and sump**] pumps in accordance with HI 14.6. Include test recordings that substantiate correct performance of pumps at design head, capacity, suction lift, speed, and horsepower.

B. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of sewerage piping systems to verify actual locations of piping connections before packaged sewage pumping station installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 INSTALLATION OF PACKAGED SEWAGE PUMPING STATIONS

A. Install packaged sewage pumping station components where indicated, in accordance with specific equipment and piping arrangement indicated.

B. Shell Base Supports: Form from structural-steel beams, of number and lengths required to support bottom of shell and to anchor beams to concrete foundation.

1. Use elevator blocks attached to bottom of shell to slope station floor **1 inch in 10 ft. (25.4 mm in 3 m)** down toward sump.

C. Grout under and around shell. Ensure that there are no voids between foundation slab and underslab of pumping station.

D. Fill voids between shell sidewalls, sleeves, and piping and make watertight seal with grout.

E. Connect anode conductors to grounding lugs on steel housing.

F. Join separate sections of housing by field welding.

G. Field weld entrance tube to housing.

3.4 PIPING CONNECTIONS

A. Sanitary sewer piping installation requirements are specified in Section 333115 "Site Sanitary Sewerage Piping." Drawings indicate general arrangement of piping.

B. Install piping adjacent to machine to allow service and maintenance.

3.5 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 IDENTIFICATION

A. Install identifying labels permanently attached to equipment.

B. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.

C. Arrange for installing green[**warning tape or**] detectable warning tape over outside edges of underground packaged sewage pumping stations. Tape materials and their installation are specified in Section 312000 "Earth Moving."

3.7 PAINTING

A. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with an epoxy-polyamide paint in accordance with SSPC-Paint 16.

B. Paint field-welded areas to match factory coating.

3.8 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Adjust pump, accessory, and control settings, and safety and alarm devices.
3. <**Insert, in separate subparagraphs, startup steps if any**>.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service, Including Testing: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. After installing packaged sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
2. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Packaged sewage pumping stations will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain packaged sewage pumping stations. See Section 017900 "Demonstration and Training."

END OF SECTION 33 32 00 00

Task	Specification	Specification Description
33 32 16 00	33 32 00 00	Site Packaged Sewage Pumping Stations
33 40 00 00	22 14 13 00	Storm Drainage Piping
33 41 00 00	22 14 13 00	Storm Drainage Piping
33 41 16 13	22 14 13 00	Storm Drainage Piping
33 41 16 13	33 42 00 00	Stormwater Conveyance
33 41 16 13	33 46 00 00	Subdrainage
33 41 19 00	22 14 13 00	Storm Drainage Piping
33 41 19 13	22 14 13 00	Storm Drainage Piping
33 41 19 13	33 46 00 00	Subdrainage

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SECTION 33 42 00 00 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron, culvert pipe and fittings.
4. Ductile-iron, pressure pipe and fittings.
5. Corrugated-steel pipe and fittings.
6. Corrugated-aluminum pipe and fittings.
7. ABS pipe and fittings.
8. Corrugated-PE pipe and fittings.
9. PVC pipe and fittings.
10. Fiberglass sewer pipe and fittings.
11. Concrete pipe and fittings.
12. Nonpressure transition couplings.
13. Pressure pipe couplings.
14. Expansion joints and deflection fittings.
15. Backwater valves.
16. Cleanouts.
17. Drains.
18. Concrete trench drain forming system.
19. Encasement for piping.
20. Manholes.
21. Polymer-concrete, channel drainage systems.
22. Plastic, channel drainage systems.
23. Catch basins.
24. Stormwater inlets.
25. Stormwater detention structures.
26. Pipe outlets.
27. Dry wells.
28. Stormwater disposal systems.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. [**Catch basins**][**stormwater inlets**][**and**][**dry wells**]. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers,

design calculations, and concrete design-mix reports.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than **1 inch equals 50 feet (1:500)** and vertical scale of not less than **1 inch equals 5 feet (1:50)**. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Piping materials are to bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes in accordance with manufacturer's written rigging instructions.

D. Handle [**catch basins**][**and**][**stormwater inlets**] in accordance with manufacturer's written rigging instructions.

1.7 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain hub-and-spigot, cast-iron soil pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Class: ASTM A74, [**Service**][**and**][**Extra Heavy**] class(es).

E. Gaskets: ASTM C564, rubber.

F. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain hubless cast-iron soil pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A888 or CISPI 301.

E. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain CISPI, hubless-piping couplings from single manufacturer.
4. Description: Stainless steel corrugated shield; stainless steel bands and tightening devices; and rubber sleeve with integral, center pipe stop.
5. Standards:

    a. ASTM C1277 and CIPSI 310 for couplings.
    b. ASTM C564 for gaskets.

F. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain heavy-duty, hubless-piping couplings from single manufacturer.
4. Description: Stainless steel shield; stainless steel bands and tightening devices; and rubber sleeve with integral, center pipe stop.
5. Standards:

    a. ASTM C1277 and ASTM C1540 for couplings.
    b. ASTM C564 for rubber gaskets.

G. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**MG Coupling**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**MG Coupling**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron, hubless-piping couplings from single manufacturer.
4. Description: Two-piece, cast-iron housing; stainless steel bolts and nuts; and rubber sleeve with integral, center pipe stop.
5. Standards:

    a. ASTM C1277 for couplings.
    b. ASTM A48/A48M for cast-iron castings.
    c. ASTM C564 for gaskets.

2.3 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

A. Pipe: ASTM A716, for push-on joints.

B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153/A21.53, for push-on joints.

D. Gaskets: AWWA C111/A21.11, rubber.

2.4 PPE Channel Drainage Systems

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.5 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Cast Iron Pipe Company**]
2. [**McWane Ductile; a part of the McWane family of companies**]
3. [**U.S. Pipe**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Cast Iron Pipe Company**]
2. [**McWane Ductile; a part of the McWane family of companies**]
3. [**U.S. Pipe**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain ductile-iron, pressure pipe and fittings from single manufacturer.

D. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

E. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.6 CORRUGATED-STEEL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**American Piping Products**]
2. [**Specialty Pipe & Tube**]
3. [**Steel Mart, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Piping Products**]
2. [**Specialty Pipe & Tube**]
3. [**Steel Mart, Inc.**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain corrugated-steel pipe and fittings from single manufacturer.

D. Description: ASTM A760/A760M, Type I with fittings of similar form and construction as pipe.

1. Special-Joint Bands: Corrugated steel with O-ring seals.
2. Standard-Joint Bands: Corrugated steel.
3. Coating: [**Aluminum**][**Zinc**].

2.7 CORRUGATED-ALUMINUM PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Brunner Enterprises, Inc.**]
2. [**Continental Steel & Tube**]
3. [**Sapa North America**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Brunner Enterprises, Inc.**]
2. [**Continental Steel & Tube**]
3. [**Sapa North America**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain corrugated-aluminum pipe and fittings from single manufacturer.

D. Description: ASTM B745/B745M, Type I with fittings of similar form and construction as pipe.

1. Special-Joint Bands: Corrugated aluminum with O-ring seals.
2. Standard-Joint Bands: Corrugated aluminum.

2.8 ABS PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Charlotte Pipe and Foundry Company**]
2. [**JM Eagle**]
3. [**Royal Building Products, a Westlake Company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Charlotte Pipe and Foundry Company**]
2. [**JM Eagle**]
3. [**Royal Building Products, a Westlake Company**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain ABS pipe and fittings from single manufacturer.

D. NSF Marking: Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

E. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

F. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

G. ABS Socket Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.

H. Gaskets: ASTM F477, elastomeric seals.

I. Solvent Cement: ASTM D2235.

2.9 CORRUGATED-PE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Emco Industrial Plastics**]
2. [**Industrial Specialties Mfg, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Emco Industrial Plastics**]
2. [**Industrial Specialties Mfg, Inc.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain corrugated-PE pipe and fittings from single manufacturer.

D. Corrugated-PE Drainage Pipe and Fittings NPS 3 to NPS 10 (DN 80 to DN 250): AASHTO M 252, Type S, with smooth waterway for coupling joints.

E. Corrugated-PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294, Type S, with smooth waterway for coupling joints.

F. Corrugated-PE Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

G. Corrugated-PE Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings.

2.10 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Charlotte Pipe and Foundry Company**]
2. [**GF Piping Systems**]
3. [**JM Eagle**]
4. [**National Pipe and Plastic, Inc. (Oldcastle)**]
5. [**North America Pipe Corporation**]
6. [**Rocky Mountain Colby Pipe Company**]
7. [**Silver-line Plastics**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Charlotte Pipe and Foundry Company**]
2. [**GF Piping Systems**]
3. [**JM Eagle**]
4. [**National Pipe and Plastic, Inc. (Oldcastle)**]
5. [**North America Pipe Corporation**]
6. [**Rocky Mountain Colby Pipe Company**]
7. [**Silver-line Plastics**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.

D. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

E. PVC Cellular-Core Piping:

1. PVC Cellular-Core Pipe and Fittings: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D3034, [**SDR 35**]<**Insert SDR**>, PVC socket-type fittings.

F. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

G. PVC Profile Sewer Piping:

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

H. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D3034, [**SDR 35**]<**Insert SDR**>, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

I. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, [**T-1**][**T-2**] wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

J. PVC Pressure Piping:

1. Pipe: AWWA C900, [**Class 100**][**Class 150**][**and**][**Class 200**] PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, [**Class 100**][**Class 150**][**and**][**Class 200**] PVC pipe with bell ends
3. Gaskets: ASTM F477, elastomeric seals.

K. PVC Water-Service Piping:

1. Pipe: ASTM D1785, [**Schedule 40**][**and**][**Schedule 80**] PVC, with plain ends for solvent-cemented joints.
2. Fittings: [**ASTM D2466, Schedule 40**][**and**][**ASTM D2467, Schedule 80**] PVC, socket type.

L. Adhesive Primer: ASTM F656.

2.11 FIBERGLASS SEWER PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Augusta Fiberglass**]
2. [**Industrial Fiberglass Specialties, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Augusta Fiberglass**]
2. [**Industrial Fiberglass Specialties, Inc.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain fiberglass sewer pipe and fittings from single manufacturer.

D. Fiberglass Sewer Pipe: ASTM D3262, RTRP for gasketed joints fabricated with [**Type 2, polyester**][**Type 4, epoxy**][**Type 2, polyester or Type 4, epoxy**] resin.

1. Liner: [**Reinforced thermoset**][**Nonreinforced thermoset**][**Thermoplastic**][**No liner**].
2. Grade: [**Reinforced, surface layer matching pipe resin**][**Nonreinforced, surface layer matching pipe resin**][**No surface layer**]<**Insert grade**>.
3. Stiffness: [**9 psig (62 kPa)**][**18 psig (124 kPa)**][**36 psig (248 kPa)**][**72 psig (496 kPa)**].

E. Fiberglass Nonpressure Fittings: ASTM D3840, RTRF for gasketed joints.

1. Laminating Resin: [**Type 1, polyester**][**Type 2, epoxy**][**Type 1, polyester or Type 2, epoxy**] resin.
2. Reinforcement: Grade with finish compatible with resin.

F. Gaskets: ASTM F477, elastomeric seals.

2.12 CONCRETE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**FOLTZ Concrete Pipe Co.**]
2. [**Northern Concrete Pipe, Inc.**]
3. [**Rinker Materials Corporation, Concrete Pipe Division**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**FOLTZ Concrete Pipe Co.**]
2. [**Northern Concrete Pipe, Inc.**]
3. [**Rinker Materials Corporation, Concrete Pipe Division**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.

D. Nonreinforced-Concrete Sewer Pipe and Fittings: **ASTM C14 (ASTM C14M)**, [**Class 1**][**Class 2**][**Class 3**], with [**bell-and-spigot**][**or**][**tongue-and-groove**] ends and [**gasketed joints with ASTM C443 (ASTM C443M), rubber gaskets**][**sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant**].

E. Reinforced-Concrete Sewer Pipe and Fittings: **ASTM C76 (ASTM C76M)**.

1. [**Bell-and-spigot**][**or**][**tongue-and-groove**] ends and [**gasketed joints with ASTM C443 (ASTM C443M), rubber gaskets**][**sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant**]
2. Class I, Wall [**A**][**B**].
3. Class II, Wall [**A**][**B**][**C**].
4. Class III, Wall [**A**][**B**][**C**].
5. Class IV, Wall [**A**][**B**][**C**].
6. Class V, Wall [**B**][**C**].

2.13 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-

resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: **ASTM C443 (ASTM C443M)**, rubber.
2. For Cast-Iron Soil Pipes: ASTM C564, rubber.
3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dallas Specialty & Mfg. Co.**]
   b. [**Fernco Inc**]
   c. [**Logan Clay Pipe**]
   d. [**Mission Rubber Company, LLC**]
   e. [**NDS Inc**]
   f. [**Plastic Oddities**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dallas Specialty & Mfg. Co.**]
   b. [**Fernco Inc**]
   c. [**Logan Clay Pipe**]
   d. [**Mission Rubber Company, LLC**]
   e. [**NDS Inc**]
   f. [**Plastic Oddities**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain unshielded, flexible couplings from single manufacturer.
4. Description: Elastomeric sleeve with[**stainless steel shear ring and**] corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cascade Waterworks Mfg. Co.**]
   b. [**Dallas Specialty & Mfg. Co.**]
   c. [**Mission Rubber Company, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Dallas Specialty & Mfg. Co.**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain shielded, flexible couplings from single manufacturer.
4. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fernco Inc**]
b. [**Logan Clay Pipe**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fernco Inc**]
b. [**Logan Clay Pipe**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ring-type, flexible couplings from single manufacturer.
4. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.14 PRESSURE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cascade Waterworks Mfg. Co.**]
2. [**Dresser Utility Solutions**]
3. [**Ford Meter Box Company, Inc. (The)**]
4. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
5. [**JCM Industries, Inc**]
6. [**Romac Industries, Inc.**]
7. [**Victaulic Company**]
8. [**Viking Johnson**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Cascade Waterworks Mfg. Co.**]
2. [**Dresser Utility Solutions**]
3. [**Ford Meter Box Company, Inc. (The)**]
4. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
5. [**JCM Industries, Inc**]
6. [**Romac Industries, Inc.**]
7. [**Victaulic Company**]
8. [**Viking Johnson**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pressure pipe couplings from single manufacturer.

D. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.

E. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include [**150-psig (1035-kPa)**][**200-psig (1380-kPa)**]<**Insert psig (kPa)**> minimum pressure rating and ends sized to fit adjoining pipes.

F. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].

G. Gasket Material: Natural or synthetic rubber.

H. Metal Component Finish: Corrosion-resistant coating or material.

2.15 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**EBAA Iron Sales, Inc.**]
    b. [**Romac Industries, Inc.**]
    c. [**Star Pipe Products**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**EBAA Iron Sales, Inc.**]
    b. [**Romac Industries, Inc.**]
    c. [**Star Pipe Products**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron, flexible expansion joints from single manufacturer.
4. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for **250-psig (1725-kPa)** minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Dresser Utility Solutions**]
    b. [**EBAA Iron Sales, Inc.**]
    c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    d. [**JCM Industries, Inc**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Dresser Utility Solutions**]
    b. [**EBAA Iron Sales, Inc.**]
    c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    d. [**JCM Industries, Inc**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron expansion joints from single manufacturer.
4. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile iron [**or**][**steel with protective coating**]; bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53.
5. Pressure Rating: **250-psig (1725-kPa)** minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**EBAA Iron Sales, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**EBAA Iron Sales, Inc.**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
4. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include AWWA C111/A21.11, ductile-iron glands, rubber gaskets, and steel bolts. Include AWWA C111/A21.11 ductile-iron glands, rubber gaskets, and steel bolts.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.

2.16 BACKWATER VALVES

A. Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron backwater valves from single manufacturer.
4. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
5. Horizontal type; with swing check valve and hub-and-spigot ends.
6. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
7. Terminal type; with bronze seat, swing check valve, and hub inlet.

B. PVC Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Endura; a brand of IPEX**]
    b. [**IPS Corporation**]
    c. [**NDS Inc**]
    d. [**Plastic Oddities**]
    e. [**Sioux Chief Manufacturing Company, Inc.**]
    f. [**Zurn Industries, LLC**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Endura; a brand of IPEX**]
    b. [**IPS Corporation**]

c. [**NDS Inc**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain PVC backwater valves from single manufacturer.
4. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.17 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron cleanouts from single manufacturer.
4. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside caulk or spigot connection and countersunk, tapered-thread, brass closure plug.
5. Top-Loading Classification(s): [**Light Duty**][**Medium Duty**][**Heavy Duty**][**and**][**Extra-Heavy Duty**].
6. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Endura; a brand of IPEX**]

b. [**IPS Corporation**]
c. [**NDS Inc**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Endura; a brand of IPEX**]
b. [**IPS Corporation**]
c. [**NDS Inc**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain PVC cleanouts from single manufacturer.
4. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.18 DRAINS

A. Cast-Iron Area Drains:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Neenah Foundry Company**]
e. [**Tyler Pipe; a subsidiary of McWane Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Neenah Foundry Company**]
e. [**Tyler Pipe; a subsidiary of McWane Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron area drains from single manufacturer.
4. Description: ASME A112.6.3 gray-iron round body with anchor flange and round[**secured**] grate. Include bottom outlet with inside caulk or spigot connection, of sizes indicated.
5. Top-Loading Classification(s): [**Medium Duty**][**and**][**Heavy Duty**].

B. Cast-Iron Trench Drains:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. [**Zurn Industries, LLC**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. [**Zurn Industries, LLC**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron trench drains from single manufacturer.
4. Description: ASME A112.6.3, **6-inch- (150-mm-)** wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular[**secured**] grate. Include units of total length indicated and quantity of bottom outlets with inside caulk or spigot connections, of sizes indicated.
5. Top-Loading Classification(s): [**Medium Duty**][**Heavy Duty**][**and**][**Extra-Heavy Duty**].

C. Steel Trench Drains:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Rockford Sanitary Systems, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Rockford Sanitary Systems, Inc**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain steel trench drains from single manufacturer.

4. Description: Factory fabricated from ASTM A242/A242M, welded steel plate, to form rectangular body with uniform bottom downward slope of 2 percent toward outlet, anchor flange, and grate. Include units of total length indicated, bottom outlet of size indicated, outlet strainer, acid-resistant enamel coating on inside and outside surfaces, and grate with openings of total free area at least two times cross-sectional area of outlet.
5. Plate Thicknesses: [**1/8 inch (3.2 mm)**][**and**][**1/4 inch (6.4 mm)**].
6. Overall Widths: [**7-1/2 inches (190 mm)**][**and**][**12-1/3 inches (313 mm)**].

D. Grate Openings: [**1/4 inch (6.4 mm) circular**][**3/8 inch (9.5 mm) circular**][**3/8 inch (9.5 mm) circular or 3/8-by-3-inch (9.5-by-76-mm) slots**][**3/8-by-3-inch (9.5-by-76-mm) slots**].

2.19 CONCRETE TRENCH DRAIN FORMING SYSTEM

A. Concrete Trench Drain Forming System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABT, Inc.**]
    b. [**Eric'sons Dura Trench**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABT, Inc.**]
    b. [**Eric'sons Dura Trench**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain concrete trench drain forming system from single manufacturer.
4. Description: Radius trench drain forming system including a removable form that is customizable for width, depth, length, shape, slope, frame material, and grate material.
5. Form Bottom: [**Smooth radius**][**Vee**][**Flat**]<**Insert option**>.
6. Form Use: [**Single use**][**or**][**reusable**].
7. Form Covers: Plywood or metal to keep concrete out of trench form during installation.
8. Width: [**8 inches (203 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**][**18 inches (457 mm)**][**24 inches (610 mm)**]<**Insert width**> inside dimension.
9. Depth: [**See drawings**]<**Insert dimension**>.
10. Length: [**See drawings**]<**Insert dimension**>.
11. Bottom Shape: [**Smooth radius**][**Vee**]<**Insert shape**>.
12. Slope: [**Level - no slope**][**0.5 percent**][**1.0 percent**]<**Insert slope**>.
13. Frame/Grate Seat:

    a. Load Bearing, <**Insert loading requirement**>.
    b. Material: [**Powder-coated steel**][**Galvanized steel**][**Iron**][**Aluminum**][**Plastic**][**FRP**][**Stainless steel**]<**Insert material**>.

14. Concrete Anchors: [**18 inches (457 mm) on center**]<**Insert spacing**>
15. Grate:

    a. Manufacturer's Load Bearing Designation: "[**Heavy**][**Medium**] Duty."

b. Material: [**Ductile iron**][**FRP**][**Galvanized steel**][**Cast iron**][**Stainless steel**]<**Insert material**>.
c. Grate Type: [**ADA**][**Heel-proof**][**slotted**][**perforated**][**bar**]<**Insert grate type**>.

2.20 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Material: [**Linear low-density polyethylene film of 0.008-inch (0.20-mm)**][**or**][**cross-laminated HDPE film of 0.004-inch (0.10-mm)**] minimum thickness.

C. Form: [**Sheet**][**or**][**tube**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

2.21 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: **ASTM C478 (ASTM C478M)**, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (102-mm)** minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: **4-inch (102-mm)** minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Description: ASTM C913; designed in accordance with ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.

3. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
4. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
5. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
6. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
7. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.

C. Fiberglass Manholes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Associated Fiberglass Enterprises**]
    b. [**Containment Solutions, Inc**]
    c. [**L. F. Manufacturing, Inc**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Associated Fiberglass Enterprises**]
    b. [**Containment Solutions, Inc**]
    c. [**L. F. Manufacturing, Inc**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fiberglass manholes from single manufacturer.
4. Description: ASTM D3753.
5. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
6. Ballast: Increase thickness of concrete base as required to prevent flotation.
7. Base Section: Concrete, **6-inch (150-mm)** minimum thickness.
8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

D. Manhole Frames and Covers:

1. Description: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (102-mm-)** minimum width flange and **26-inch- (660-mm-)** diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: [**ASTM A536, Grade 60-40-18 ductile**][**ASTM A48/A48M, Class 35 gray**] iron unless otherwise indicated.

2.22 CONCRETE

A. General: Cast-in-place concrete in accordance with **ACI 318 (ACI 318M)**, **ACI 350 (ACI 350M)**, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

   a. Invert Slope: [**1**][**2**] percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

   a. Slope: [**4**][**8**] percent.

D. Ballast and Pipe Supports: Portland cement design mix, **3000 psi (20.7 MPa)** minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

2.23 POLYMER-CONCRETE, CHANNEL DRAINAGE SYSTEMS

A. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Forté Composites, Inc.**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**Josam Company**]
g. [**MultiDrain Systems, Inc.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Forté Composites, Inc.**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**Josam Company**]
g. [**MultiDrain Systems, Inc.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain narrow, sloped-invert channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
b. Include extension sections necessary for required depth.
c. Dimensions: **4-inch (102-mm)** inside width. Include number of units required to form total lengths indicated.
d. Frame: [**Gray-iron or galvanized steel for grates**][**Not required**].
e. Joining Section: As recommended in writing by system manufacturer.

6. Grates: Manufacturer's designation "[**heavy**][**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

7. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

B. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons Dura Trench**]
d. [**Forté Composites, Inc.**]
e. [**Josam Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons Dura Trench**]
d. [**Forté Composites, Inc.**]
e. [**Josam Company**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain narrow, level-invert channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

a. Include rounded bottom, with level invert and with **NPS 4 (DN 100)** outlets in number and locations indicated.
b. Dimensions: [**5-inch (127-mm)**]<**Insert inches (mm)**> inside width and [**9-3/4 inches (248 mm)**]<**Insert inches (mm)**> deep. Include number of units required to form total lengths indicated.
c. Frame: [**Gray-iron or galvanized steel for grates**][**Not required**].

6. Grates: Manufacturer's designation "[**heavy**][**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

7. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons Dura Trench**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]

e. [**Josam Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons Dura Trench**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Josam Company**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wide, level-invert channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.

a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
b. Dimensions: [**8-inch (203-mm)**]<**Insert inch (mm)**> inside width and [**13-3/4 inches (350 mm)**]<**Insert inches (mm)**> deep. Include number of units required to form total lengths indicated.
c. Frame: [**Gray iron or galvanized steel for grates**][**Not required**].
d. Channel-Section Joining and Fastening Materials: As recommended in writing by system manufacturer.

6. Grates: Manufacturer's designation "[**heavy**][**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

7. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

D. Drainage Specialties: Precast, polymer-concrete units.

1. Large Catch Basins:

a. **24-by-12-inch (610-by-305-mm)** polymer-concrete body, with outlets in quantities and sizes indicated.
b. Gray-iron slotted grate.
c. Frame: Include gray-iron or steel frame for grate.

2. Small Catch Basins:

a. **19- to 24-inch by approximately 6-inch (483- to 610-mm by approximately 150-mm)** polymer-concrete body, with outlets in quantities and sizes indicated.
b. Gray-iron slotted grate.

c. Frame: Include gray-iron or steel frame for grate.

3. Oil Interceptors:

a. Polymer-concrete body with interior baffle and four steel support channels and two **1/4-inch- (6.4-mm-)** thick, steel-plate covers.
b. Capacity: [**140 gal. (530 L)**][**200 gal. (757 L)**][**260 gal. (984 L)**].
c. Inlet and Outlet: [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**].

4. Sediment Interceptors:

a. **27-inch- (686-mm-)** square, polymer-concrete body, with outlets in quantities and sizes indicated.
b. **24-inch- (610-mm-)** square, gray-iron frame and slotted grate.

2.24 PLASTIC, CHANNEL DRAINAGE SYSTEMS

A. General Requirements for Plastic, Channel Drainage Systems:

1. Modular system of plastic channel sections, grates, and appurtenances.
2. Designed so grates fit into frames without rocking or rattling.
3. Number of units required to form total lengths indicated.

B. FRP Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACO, Inc.**]
b. [**Aquaduct, Inc.**]
c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACO, Inc.**]
b. [**Aquaduct, Inc.**]
c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain FRP channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.

a. Dimensions: [**4 inches (102 mm)**][**4 or 6 inches (102 or 152 mm)**][**6 inches (152 mm)**][**6 or 8 inches (152 or 203 mm)**][**8 inches (203 mm)**] wide. Include number of units required to form total lengths indicated.

b. Frame: [**Galvanized steel**][**Stainless steel**][**Manufacturer's standard metal**]<**Insert material**> for grates.

6. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

7. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. HDPE or PE Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Tuf-Tite Corporation**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Tuf-Tite Corporation**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain HDPE or PE channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Interlocking-joint, HDPE or PE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.

6. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Color: <**Insert color or delete subparagraph**>.

7. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.25 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: **ASTM C478 (ASTM C478M)**, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (102-mm)** minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: **4-inch (102-mm)** minimum thickness, **48-inch (1200-mm)** diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 225-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and grate.
8. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
9. Pipe Connectors: **ASTM C923 (ASTM C923M)**, resilient, of size required, for each pipe connecting to base section.

B. Designed Precast Concrete Catch Basins: ASTM C913, precast, reinforced concrete; designed in accordance with ASTM C890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 225-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and grate.
4. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
5. Pipe Connectors: **ASTM C923 (ASTM C923M)**, resilient, of size required, for each pipe connecting to base section.

C. Rectangular Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: **24 by 24 inches (610 by 610 mm)** minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

D. Round Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with

4-inch- (102-mm-) minimum width flange, and 26-inch- (660-mm-) diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.26 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening[**, of materials and dimensions in accordance with utility standards**].

B. Gutter Inlets: Made with horizontal gutter opening[**, of materials and dimensions in accordance with utility standards**]. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings[**, of materials and dimensions in accordance with utility standards**]. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty[**, in accordance with utility standards**].

2.27 STORMWATER DETENTION STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed in accordance with ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Ballast: Increase thickness of concrete as required to prevent flotation.
2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 229-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and cover.
3. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of structure to finished grade is less than [60 inches (1500 mm)]<**Insert** inches (mm)>.

B. Manhole Frames and Covers: ASTM A536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange, and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

2.28 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Riprap Basins: Broken, irregularly sized and shaped, graded stone in accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control."

1. Average Size:

   a. NSSGA No. R-3, screen opening 2 inches (51 mm).
   b. NSSGA No. R-4, screen opening 3 inches (76 mm).

c. NSSGA No. R-5, screen opening **5 inches (127 mm)**.

C. Filter Stone: In accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.

D. Energy Dissipaters: In accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, **3-ton (2721-kg)** average weight armor stone, unless otherwise indicated.

2.29 DRY WELLS

A. ASTM C913, precast, reinforced, perforated concrete rings. Include the following:

1. Floor: Cast-in-place concrete.
2. Cover: Liftoff-type concrete cover with cast-in lift rings.
3. Wall Thickness: **4 inches (102 mm)** minimum with **1-inch (25-mm)** diameter or **1-by-3-inch- (25-by-76-mm-)** maximum slotted perforations arranged in rows parallel to axis of ring.

    a. Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
    b. Ring Construction: Designed to be self-aligning.

4. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.

B. Manufactured PE Dry Wells:

1. Description: Manufactured PE side panels and top cover that assemble into **50-gal. (190-L)** storage capacity units.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**NDS Inc**]
    b. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**NDS Inc**]
    b. <**Insert manufacturer's name**>

4. Source Limitations: Obtain manufactured PE dry wells from single manufacturer.
5. Side Panels: With knockout ports for piping and seepage holes.
6. Top Cover: With knockout port for drain.
7. Filter Fabric: As recommended by unit manufacturer.
8. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.

C. Constructed-in-place aggregate type. Include the following:

1. Lining:

    a. Clay or concrete bricks.

b. Concrete blocks or precast concrete rings with notches or weep holes.

2. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
3. Cover: Precast, reinforced-concrete slab, designed for structural loading in accordance with ASTM C890 and made in accordance with ASTM C913. Include slab dimensions that will extend **12 inches (300 mm)** minimum beyond edge of excavation, with bituminous coating over entire surface. Cast cover with opening for manhole in center.
4. Manhole: **24-inch- (610-mm-)** diameter, reinforced-concrete access lid with steel lift rings. Include bituminous coating over entire surface.

2.30 STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Drainage Systems, Inc**]
   b. [**CULTEC, Inc**]
   c. [**Hancor Inc.**]
   d. [**Infiltrator Systems Inc**]
   e. [**Interface H2O**]
   f. [**StormTech LLC**]
   g. [**Suntree Technologies, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Drainage Systems, Inc**]
   b. [**CULTEC, Inc**]
   c. [**Hancor Inc.**]
   d. [**Infiltrator Systems Inc**]
   e. [**Interface H2O**]
   f. [**StormTech LLC**]
   g. [**Suntree Technologies, Inc.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain chamber systems from single manufacturer.
4. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
5. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
6. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of **4 oz./sq. yd. (135 g/sq. m)**.

B. Piping Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252 for **NPS 10 (DN 250)** and smaller, AASHTO M 294 for **NPS 12 to NPS 60 (DN 300 to DN 1500)**. Include proprietary fittings, couplings, seals, and filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advanced Drainage Systems, Inc**]
    b. [**Hancor Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advanced Drainage Systems, Inc**]
    b. [**Hancor Inc.**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pipe systems from single manufacturer.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping in accordance with the following:

1. Install piping pitched down in direction of flow.
2. Install piping [**NPS 6 (DN 150)**]<**Insert value**> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.

3. Install piping with [36-inch- (915-mm-)][48-inch- (1220-mm-)][60-inch- (1520-mm-)][72-inch- (1830-mm-)]<**Insert** inch- (mm-)> minimum cover.
4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
7. Install corrugated-steel piping in accordance with ASTM A798/A798M.
8. Install corrugated-aluminum piping in accordance with ASTM B788/B788M.
9. Install ABS sewer piping in accordance with ASTM D2321 and ASTM F1668.
10. Install PE corrugated sewer piping in accordance with ASTM D2321.
11. Install PVC cellular-core piping in accordance with ASTM D2321 and ASTM F1668.
12. Install PVC sewer piping in accordance with ASTM D2321 and ASTM F1668.
13. Install PVC profile gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
14. Install PVC water-service piping in accordance with ASTM D2321 and ASTM F1668.
15. Install fiberglass sewer piping in accordance with ASTM D3839 and ASTM F1668.
16. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
17. Install reinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

G. Install force-main pressure piping in accordance with the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
2. Install piping with [36-inch- (915-mm-)][48-inch- (1220-mm-)][60-inch- (1520-mm-)][72-inch- (1830-mm-)]<**Insert** inch- (mm-)> minimum cover.
3. Install ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41.
4. Install ductile-iron special fittings in accordance with AWWA C600.
5. Install PVC pressure piping in accordance with AWWA M23, or ASTM D2774 and ASTM F1668.
6. Install PVC water-service piping in accordance with ASTM D2774 and ASTM F1668.

H. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping in accordance with the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.
3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron culvert piping in accordance with AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
6. Join corrugated-steel sewer piping in accordance with ASTM A798/A798M.

7. Join corrugated-aluminum sewer piping in accordance with ASTM B788/B788M.
8. Join ABS sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
9. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.
10. Join PVC cellular-core piping in accordance with ASTM D2321 and ASTM F891 for solvent-cemented joints.
11. Join PVC corrugated sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
12. Join PVC sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasketed joints.
13. Join PVC profile gravity sewer piping in accordance with ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
14. Join fiberglass sewer piping in accordance with ASTM D3839 for elastomeric-seal joints.
15. Join nonreinforced-concrete sewer piping in accordance with **ASTM C14 (ASTM C14M)** and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
16. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
17. Join dissimilar pipe materials with nonpressure-type flexible couplings.

B. Join force-main pressure piping in accordance with the following:

1. Join ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings in accordance with AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping in accordance with AWWA M23 for gasketed joints.
4. Join PVC water-service piping in accordance with ASTM D2855 for solvent-cemented joints.
5. Join dissimilar pipe materials with pressure-type couplings.

3.4 INSTALLATION OF BACKWATER VALVES

A. Install horizontal-type backwater valves in piping where indicated.

B. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.

C. Install terminal-type backwater valves on end of piping and in manholes where indicated.

3.5 INSTALLATION OF CLEANOUTS

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in [**earth or unpaved foot-traffic**]<**Insert area type**> areas.
2. Use Medium-Duty, top-loading classification cleanouts in [**paved foot-traffic**]<**Insert area type**> areas.
3. Use Heavy-Duty, top-loading classification cleanouts in [**vehicle-traffic service**]<**Insert area type**> areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in [**roads**]<**Insert area**>.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, [**18 by 18 by 12 inches (450 by 450 by 300 mm)**]<**Insert inches (mm)**> deep. Set with tops [**1 inch (25 mm)**]<**Insert inch(es (mm)**> above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 INSTALLATION OF DRAINS

A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in [**earth or unpaved foot-traffic**]<**Insert area type**> areas.
2. Use Medium-Duty, top-loading classification drains in [**paved foot-traffic**]<**Insert area type**> areas.
3. Use Heavy-Duty, top-loading classification drains in [**vehicle-traffic service**]<**Insert area type**> areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in [**roads**]<**Insert area**>.

B. Embed drains in **4-inch- (102-mm-)** minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in [**4-inch- (102-mm-)**]<**Insert inch- (mm-)**> minimum concrete around bottom and sides.

3.7 INSTALLATION OF MANHOLES

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [**3 inches (76 mm)**]<**Insert inches (mm)**> above finished surface elsewhere unless otherwise indicated.

3.8 INSTALLATION OF CATCH BASINS

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.9 INSTALLATION OF STORMWATER INLETS/OUTLETS

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.10 INSTALLATION OF DRY WELLS

A. Excavate hole to diameter of at least **6 inches (150 mm)** greater than outside of dry well. Do not extend excavation into ground-water table.

B. Install precast, concrete-ring dry wells in accordance with the following:

1. Assemble rings to depth indicated.
2. Extend rings to height where top of cover will be approximately **8 inches (203 mm)** below finished grade.
3. Backfill bottom of inside of rings with filtering material to level at least **12 inches (300 mm)** above bottom.
4. Extend effluent inlet pipe **12 inches (300 mm)** into rings and terminate into side of tee fitting.
5. Backfill around outside of rings with filtering material to top level of rings.
6. Install cover over top of rings.

C. Install manufactured, PE dry wells in accordance with manufacturer's written instructions and the following:

1. Assemble and install panels and cover.
2. Backfill bottom of inside of unit with filtering material to level at least [**12 inches (300 mm)**]<**Insert inches (mm)**> above bottom.
3. Extend effluent inlet pipe [**12 inches (300 mm)**]<**Insert inches (mm)**> into unit and terminate into side of tee fitting.
4. Install filter fabric around outside of unit.
5. Install filtering material around outside of unit.

D. Install constructed-in-place dry wells in accordance with the following:

1. Install brick lining material dry and laid flat, with staggered joints for seepage. Build to diameter and depth indicated.
2. Install block lining material dry, with staggered joints and 20 percent minimum of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage. Build to diameter and depth indicated.
3. Extend lining material to height where top of manhole will be approximately [**8 inches (203 mm)**]<**Insert inches (mm)**> below finished grade.
4. Backfill bottom of inside of lining with filtering material to level at least [**12 inches (300 mm)**]<**Insert inches (mm)**> above bottom.
5. Extend effluent inlet pipe [**12 inches (300 mm)**]<**Insert inches (mm)**> into lining and terminate into side of tee fitting.
6. Backfill around outside of lining with filtering material to top level of lining.
7. Install manhole over top of dry well. Support cover on undisturbed soil. Do not support cover on lining.

3.11 CONCRETE PLACEMENT

A. Place cast-in-place concrete in accordance with **ACI 318 (ACI 318M)**.

3.12 INSTALLATION OF CHANNEL DRAINAGE SYSTEMS

A. Install with top surfaces of components, except piping, flush with finished surface.

B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

C. Embed channel sections and drainage specialties in [4-inch- (102-mm-)]<Insert inch- (mm-)> minimum concrete around bottom and sides.

D. Fasten grates to channel sections if indicated.

E. Assemble channel sections with flanged or interlocking joints.

F. Embed channel sections in [4-inch- (102-mm-)]<Insert inch- (mm-)> minimum concrete around bottom and sides.

3.13 INSTALLATION OF STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill in accordance with chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.

B. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, in accordance with piping manufacturer's written instructions.

3.14 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221414 "Storm Drainage Piping."

B. Connect force-main piping to building's storm drainage force mains specified in Section 221414 "Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."

E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

   a. [**Unshielded**][**Shielded**] flexible couplings for same or minor difference OD pipes.
   b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
   c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.15 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least [**8-inch- (203-mm-)**]<**Insert inch- (mm-)**> thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least [**36 inches (915 mm)**]<**Insert inches (mm)**> below final grade. Fill to within [**12 inches (300 mm)**]<**Insert inches (mm)**> of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.16 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use[**warning tape or**] detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.17 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches (610 mm)** of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping in accordance with ASTM F1417.

6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert psig (kPa)**>.

    a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
    b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.18 CLEANING

A. Clean interior of piping of dirt and superfluous materials.[**Flush with potable water.**]

END OF SECTION 33 42 00 00

Task	Specification	Specification Description
33 42 00 00	22 14 13 00	Storm Drainage Piping
33 42 11 00	22 14 13 00	Storm Drainage Piping
33 42 11 00	33 42 00 00	Stormwater Conveyance
33 42 11 00	33 46 00 00	Subdrainage
33 42 13 00	22 14 13 00	Storm Drainage Piping
33 42 13 00	33 42 00 00	Stormwater Conveyance
33 42 13 13	22 14 13 00	Storm Drainage Piping
33 42 13 13	33 42 00 00	Stormwater Conveyance
33 42 23 00	22 14 13 00	Storm Drainage Piping
33 42 23 00	22 11 19 00a	Electronic Air Cleaners
33 42 23 00	33 42 00 00	Stormwater Conveyance
33 42 26 00	33 42 00 00	Stormwater Conveyance
33 42 26 16	22 14 13 00	Storm Drainage Piping
33 42 26 16	33 42 00 00	Stormwater Conveyance
33 42 26 19	22 14 13 00	Storm Drainage Piping
33 42 26 19	33 42 00 00	Stormwater Conveyance
33 42 26 23	22 14 13 00	Storm Drainage Piping
33 42 26 23	33 42 00 00	Stormwater Conveyance
33 42 31 00	22 14 13 00	Storm Drainage Piping
33 42 31 00	22 11 19 00a	Electronic Air Cleaners
33 42 31 00	33 42 00 00	Stormwater Conveyance
33 42 33 00	22 14 13 00	Storm Drainage Piping
33 42 33 00	22 11 19 00a	Electronic Air Cleaners
33 42 33 00	33 42 00 00	Stormwater Conveyance
33 42 36 00	22 14 13 00	Storm Drainage Piping
33 42 36 00	33 42 00 00	Stormwater Conveyance
33 44 00 00	22 14 13 00	Storm Drainage Piping
33 44 33 00	22 14 13 00	Storm Drainage Piping
33 44 33 00	22 11 19 00a	Electronic Air Cleaners

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SECTION 33 44 36 00 - OIL WATER SEPARATOR

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for oil/water separator. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Scope
1. The separator shall be designed for gravity separation of sand, grit, settleable solids, or semisolids, and free oils (hydrocarbons and other petroleum products) from wastewater. Separator shall be installed belowground with top access at or above grade level. The source of the influent to the separator shall be gravity flow from storm water runoff, hydrocarbon spills, and/or cleaning/maintenance operations.

C. Performance
1. Influent Characteristics
a. Provide separator designed for intermittent and variable flows of water, oil, or any combination of non-emulsified oil-water mixtures. Minimum separator retention time shall be 10 minutes. Operating temperatures of the influent oil in water mixture shall range from 40 degrees F. to 80 degrees F. The specific gravity of the oils at operating temperatures shall range from 0.71 to 0.92. The specific gravity of the fresh water at operating temperatures shall range from 1.00 to 1.03.
2. Effluent Characteristics
a. The free oil and grease concentration in the effluent from the separator shall not exceed 10 mg/l (10 PPM) to satisfy requirements of the NPDES stormwater discharge permit. To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns.

D. Design Criteria
1. The separator shall be listed to Underwriters' Laboratories UL-SU2215. Construction and performance of the oil/water separators shall be in accordance with UL-SU2215. Provide certification documentation detailing criteria under which the system was tested. UL-SU2215 label shall be prominently displayed on manway covers.
2. Separator shall be designed in accordance with Stokes Law and the American Petroleum Institute Publication 421, "Monographs on Refinery Environmental Control - Management of Water Discharges; Design and Operation of Oil/Water Separators." Effective surface area calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document specified effluent quality based on complete removal of the specified oil globule at design flow. A separator with lower effective surface area than required is not permissible.
3. Separator capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters' Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, September 30, 1997, Double Wall construction with 360 degree Steel Secondary Containment. The inner steel tank shall be completely contained within the outer steel tank, enclosing 100% of the tank volume. The tank shall have a double steel shell with a space between the layers. The space between the inner and outer steel walls shall be monitored with an approved electronic leak detection device through a pipe that extends vertically to the top of the tank from a small sump at the bottom. Tank construction using thin walled primary tank with external fiberglass jacket shall not be permissible.
4. Separator Corrosion Control System shall be in strict accordance with Underwriters' Laboratories Inc. Subject UL-1746 Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks and the HighGuard® External Corrosion Protection Specifications.

5. Oil/water separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
6. Separator vessel volume shall allow for a hydraulic retention time of ten (10) minutes to ensure laminar flow conditions which result in hydraulic uniformity and high effluent quality. Volume reduction will adversely affect separator performance by increasing horizontal velocity and turbulence, therefore a separator of smaller volume is not permissible.
7. Separator shall be the standard patented product of a steel tank manufacturer regularly engaged in the production of such equipment. Manufacturer shall have at least 20 years experience in manufacturing similar units for identical applications. No subcontracting of tank fabrication shall be permitted.
8. Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation.
9. Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions. The Oil/Water Separator's dimensions and thickness shall be in strict compliance with Roark's Formulas for Stress and Strain as presented in UL 58, September 30, 1997. Calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document structural strength under specified overbearing or external pressure. A separator with a reduced shell thickness is not permissible.
10. Separator shall have an oil storage capacity equal to about 43% of the total vessel volume and an emergency oil spill capacity equal to 80% of the total vessel volume.
11. To prevent extensive shutdown and maintenance, the separator design must allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids. The use of plastic perforated tubes, spherical balls, or irregular shaped media will increase the facility's maintenance costs and shall not be permitted.
12. Separator shall consist of inlet and outlet connections, integral sand interceptor compartment, non-clogging flow distributor and energy dissipater device, stationary under flow baffle, presettling chamber for solids, sludge baffle, oil coalescing chamber with removable parallel flat/corrugated plate coalescer, with removable plates, and sectionalized removable polypropylene impingement coalescers to optimize separation of free oil from water, effluent downcomer positioned to prevent discharge of free oil that has been separated from the water, access ways for coalescers and each chamber, fittings for vent, oil pump-out, sampling, gauging, leak detection, and lifting lugs.

E. Submittals:
1. Shop Drawings: shop drawings for oil water separators shall show principal dimensions and location of all fittings.
2. Instructions: provide three complete sets of installation, operation, and maintenance instructions with separator.
3. Quality Control: Quality control, inspection procedures, and reports shall be considered part of the submittal package.

F. Warranty
1. The manufacturer shall warrant its products to be free from defects in material and workmanship for a period of one year from the date of shipment. The warranty shall be limited to repair or replacement of the defective part(s).
2. The manufacturer's warranty shall be standard limited warranty in effect at time of purchase.

1.2 PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Highland Tank, One Highland Road, Box 338, Stoystown, PA 15563, Phone 814-893-5701, FAX 893-6126, E-mail ows.info@highlandtank.com, Website http://www.highlandtank.com

B. Product
1. Provide and install Highland Tank Model HTC Series “G” UL-SU2215 approved Belowground Double Wall Parallel Flat/Corrugated Plate Gravity Displacement Oil/Water Separator with Integral Sand Interceptor Compartment. Separator shall be furnished with oil level alarm and leak detection systems. Oil/Water Separator shall be of capacity to comply with Spill Prevention Control and Countermeasures (SPCC) plan requirements at the facility. The sizing of this oil/water separator is consistent with industry protocols for complying with the minimum federal spill and discharge regulations therefore a separator of smaller volume is not permissible.
2. Separator shall be furnished with a Corella™ inclined parallel flat/corrugated plate coalescer to simultaneously separate free oil droplets and settleable or suspended solids particles from water without clogging of the coalescer.

C. Description
1. Separator shall be standard prefabricated inclined parallel flat/corrugated plate, gravity displacement type unit.
2. Separator shall be cylindrical with capacities, dimensions, construction, and thickness in strict accordance with Underwriters’ Laboratories Subject 58, Double Wall construction using flat-flanged heads. Separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
3. The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:
   a. An influent connection, flanged. An internal influent nozzle at the inlet end of the separator. Nozzle discharge to be located at the furthest diagonal point from the effluent discharge opening.
   b. An integral sand interceptor compartment containing one (1) manhole, UL approved, complete with extension, cover, gasket, and bolts. A heavy-duty bulkhead shall retain sand, grit, settleable solids or semisolids and prevent them from entering the separation chamber. Bulkhead shall have a transfer pipe.
   c. A velocity head diffusion baffle at the inlet to:
      1) reduce horizontal velocity and flow turbulence.
      2) distribute the flow equally over the separators cross sectional area.
      3) direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume.
      4) completely isolate all inlet turbulence from the separation chamber.
   d. A sediment chamber to disperse flow and collect oily solids and sediments.
   e. A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.
   f. An Oil/Water Separation Chamber containing a removable Corella™ inclined parallel flat/corrugated plate coalescer. The coalescer shall have individual removable plates, sloped towards the sediment chamber. Each coalescing polate shall be flat on the top and corrugated on the bottom. The flat top plate shall resist clogging and clotting with solids. The corrugations of each of the plate bottoms shall be shaped and positioned to enhance collisions between the rising oil droplets and coalesce between them thereby improving separator efficiency. The coalescer shall:
      1) effect separation of oil and solids from all strata of the wastewater stream.
      2) shorten the vertical distance that an oil globule or solid particle has to rise or sink, respectively, for effective removal. Minimum plate gap to be 3/4".
      3) enhance coalescence and agglomeration by causing the smaller globules and particles (those possessing smaller rising/settling rates) to coalesce and collect on the plates thereby forming larger globules and particles that separate rapidly in water.
      4) direct the flow paths of the separated oil to the surface of the separator and separated solids to the bottom of the separator.
      5) allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids.
   g. The Oil/Water Separation Chamber shall also contain a sectionalized removable “Petro-Screen”™ polypropylene impingement coalescer designed to intercept oil globules of less

than 20 microns in diameter. Heavy, one-piece impingement coalescers are not permissible.

h. An internal effluent downcomer at the outlet end of the separator, to allow for discharge from the bottom of the separation chamber only.

i. An effluent connection, flanged.

j. Fittings for vent, interface/level sensor, leak detection, waste oil pump-out, sampling, and gauge.

k. Two (2) manholes, UL approved, complete with extension, cover, gasket, and bolts. One manway shall be placed between the inlet and the parallel flat/corrugated plate coalescer to facilitate access into sediment chamber for solids removal. One manway shall be placed between the parallel flat/corrugated plate coalescer and outlet to facilitate access into the oil water separation chamber for oil removal.

l. Lifting lugs at balancing points for handling and installation.

m. Identification plates: Plates shall be affixed in prominent location and be durable and legible throughout equipment life.

n. HighGuard® Corrosion Protection System consisting of:
   1) Isolation Spool Pieces
   2) Dielectric Isolation Gaskets and Bushings
   3) External surfaces commercial grit blast, coated 75 mils DFT Self-Reinforcing Polyurethane.

o. Internal surfaces commercial grit blast and coated with 10 mils DFT heavy duty Polyurethane.

D. Accessories

1. Separator shall be supplied with an audible and visual alarm system that indicates hi oil level (visual only) and hi hi oil level (audible and visual) of oil storage in the oil/water separator and an audible and visual leak detection alarm system that indicates hydrocarbon and/or water in the interstice. A silence control shall be provided for the audible alarms. Level sensor(s) shall be intrinsically safe. Level sensor floats shall be made of stainless steel. The control panel shall contain both level sensor and detection control. The control panel shall be NEMA 4. Power to the control panel shall be as directed by the Owner.
2. Separator shall be supplied with Polyester Hold-down straps.
3. Separator shall be supplied with prefabricated Concrete Deadman Anchors.
4. Separator shall be supplied with cylindrical and/or rectangular steel Grade Level Manways designed to AASHTO H20 requirements.

1.3 EXECUTION

A. Installation

1. Installation shall be in strict compliance with manufacturer's instructions and shall comply with all applicable local, state, and federal requirements.

END OF SECTION 33 44 36 00

Task	Specification	Specification Description
33 44 36 00	22 13 19 00	Sanitary Waste Piping Specialties
33 44 36 00	22 14 13 00	Storm Drainage Piping

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SECTION 33 46 00 00 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipes and fittings.
2. Drainage conduits.
3. Drainage panels.
4. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 (DN 150) and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 (DN 200) and Larger: ASTM F667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airfield Systems, LLC**]
b. [**American Wick Drain Corporation (AWD)**]
c. [**JDR Enterprises, Inc**]
d. [**MAPEI Corporation**]
e. [**TenCate Geosynthetics**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Airfield Systems, LLC**]
    b. [**American Wick Drain Corporation (AWD)**]
    c. [**JDR Enterprises, Inc**]
    d. [**MAPEI Corporation**]
    e. [**TenCate Geosynthetics**]
    f. <**Insert manufacturer's name**>

3. Nominal Size:

    a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
    b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: PP geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D1248 and wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Varicore Technologies, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Varicore Technologies, Inc.**]
    b. <**Insert manufacturer's name**>

3. Nominal Size:

    a. 6 Inches (152 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**15 gpm (57 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
    b. 12 Inches (305 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
    c. 18 Inches (457 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven, needle-punched geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

6. Couplings: HDPE.

C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D3350 and wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Drainage Systems, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Drainage Systems, Inc**]
   b. <**Insert manufacturer's name**>

3. Nominal Size:

   a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: PP geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.
6. Couplings: Corrugated HDPE band.

D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Building Products Inc.**]
   b. [**Low & Bonar PLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Building Products Inc.**]
   b. [**Low & Bonar PLC**]
   c. <**Insert manufacturer's name**>

3. Nominal Size: **6 inches (150 mm)** high by approximately **0.9 inch (23 mm)** thick.

   a. Minimum In-Plane Flow: [**2.4 gpm (9.1 L/min.)**]<**Insert value**> at hydraulic gradient of

[**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Invisible Structures, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Invisible Structures, Inc.**]
   b. <**Insert manufacturer's name**>

3. Nominal Size:

   a. 18 Inches (0.5 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of [**82 gpm (310 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   b. 36 Inches (1 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of [**164 gpm (621 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

2.3 DRAINAGE PANELS

A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, [**36 to 60 inches (915 to 1525 mm)**]<**Insert dimensions**> wide with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Wick Drain Corporation (AWD)**]
   b. [**Dorken Systems Inc.**]
   c. [**Eljen Corporation**]
   d. [**JDR Enterprises, Inc**]
   e. [**MAPEI Corporation**]
   f. [**Mar-flex Waterproofing & Building Products**]
   g. [**Midwest Diversified Technologies Incorporated**]
   h. [**Sika Greenstreak**]

i. [**TenCate Geosynthetics**]
j. [**Thrace-LINQ, Inc.; Thrace Group**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Wick Drain Corporation (AWD)**]
b. [**Dorken Systems Inc.**]
c. [**Eljen Corporation**]
d. [**JDR Enterprises, Inc**]
e. [**MAPEI Corporation**]
f. [**Mar-flex Waterproofing & Building Products**]
g. [**Midwest Diversified Technologies Incorporated**]
h. [**Sika Greenstreak**]
i. [**TenCate Geosynthetics**]
j. [**Thrace-LINQ, Inc.; Thrace Group**]
k. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.

a. Minimum Compressive Strength: [**10,000 lbf/sq. ft. (479 kPa)**][**15,000 lbf/sq. ft. (718 kPa)**][**18,000 lbf/sq. ft. (862 kPa)**][**21,000 lbf/sq. ft. (1005 kPa)**]<**Insert value**> when tested in accordance with ASTM D1621.
b. Minimum In-Plane Flow Rate: [**2.8 gpm/ft. (35 L/min. per m)**][**7 gpm/ft. (87 L/min. per m)**][**15 gpm/ft. (186 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and compressive stress of [**25 psig (172 kPa)**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric, Nonwoven: Needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:

a. Survivability: [**Class 1**][**Class 2**][**Class 3**].
b. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.25-mm)**][**No. 70 (0.212-mm)**] sieve, maximum.
c. Permittivity: [**0.5**][**0.2**][**0.1**] per second, minimum.

5. Filter Fabric, Woven: Geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:

a. Survivability: [**Class 1**][**Class 2**][**Class 3**].
b. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.25-mm)**][**No. 70 (0.212-mm)**][**No. 30 (0.6-mm)**] sieve, maximum.
c. Permittivity: [**0.5**][**0.2**][**0.1**][**0.02**] per second, minimum.

6. Film Backing: Polymeric film bonded to drainage core surface.

B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Advanced Building Products Inc.**]
b. [**Low & Bonar PLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Building Products Inc.**]
b. [**Low & Bonar PLC**]
c. <**Insert manufacturer's name**>

3. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately **0.4 inches (10.2 mm)** thick.

a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JDR Enterprises, Inc**]
b. [**Solmax International Inc.**]
c. [**Strata Systems, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**JDR Enterprises, Inc**]
b. [**Solmax International Inc.**]
c. [**Strata Systems, Inc**]
d. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately **0.25 inches (6 mm)** thick.

a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**][**5 gpm/ft. (62 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates

range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Invisible Structures, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Invisible Structures, Inc.**]
b. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately **1 inch (25 mm)** thick.

a. Minimum In-Plane Flow Rate: [**40 gpm/ft. (500 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

2.4 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earth Moving."

2.5 WATERPROOFING FELTS

A. Material: Comply with [**ASTM D226, Type I, asphalt**][**or**][**ASTM D227, coal-tar**]-saturated organic felt.

2.6 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from **110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m)** when tested in accordance with ASTM D4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO [**M 288 Class 2**]<**Insert class**>.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 INSTALLATION OF FOUNDATION DRAINAGE

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than **6 inches (150 mm)** deep and **12 inches (300 mm)** wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course, overlapping edges at least **4 inches (100 mm)**.

J. Install drainage panels on foundation walls as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
3. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.

K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Final backfill to finish elevations and

slope away from building.

3.4 INSTALLATION OF UNDERSLAB DRAINAGE

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least **6 inches (150 mm)** between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

H. Install horizontal drainage panels as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at inside edge of footing.
3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.5 INSTALLATION OF RETAINING-WALL DRAINAGE

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than **4 inches (100 mm)**.

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.

E. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.

G. Place drainage course in layers not exceeding **3 inches (75 mm)** in loose depth; compact each layer

placed and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course, overlapping edges at least **4 inches (100 mm)**.

I. Install drainage panels on wall as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
3. If weep holes are used instead of drainage pipe, cut **1/2-inch- (13-mm-)** diameter holes on core side at weep-hole locations. Do not cut fabric.
4. Mark horizontal calk line on wall at a point **6 inches (150 mm)** less than panel width above footing bottom. Before marking wall, subtract footing width.
5. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from **2 to 6 inches (50 to 150 mm)** below top of panel, approximately **48 inches (1200 mm)** apart.[**Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails.**] Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
7. If another panel is required on same row, cut away **4 inches (100 mm)** of installed panel core and wrap fabric over new panel.
8. If additional rows of panel are required, overlap lower panel with **4 inches (100 mm)** of fabric.
9. Cut panel as necessary to keep top **12 inches (300 mm)** below finish grade.
10. For inside corners, bend panel. For outside corners, cut core to provide **3 inches (75 mm)** for overlap.

J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

3.6 INSTALLATION OF LANDSCAPING DRAINAGE

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least **6 inches (150 mm)** between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with [**adhesive**][**or**][**tape**].

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within **12 inches (300 mm)** of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course,

overlapping edges at least **4 inches (100 mm)**.

I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

3.7 INSTALLATION OF PIPING

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping level and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
2. Underslab Subdrainage: Install piping level.
3. Plaza Deck Subdrainage: Install piping level.
4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of [**0.5**]<**Insert value**> percent and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
6. Lay perforated pipe with perforations down.
7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping in accordance with ASTM D2321.

3.8 CONSTRUCTION OF PIPE JOINTS

A. Join perforated PE pipe and fittings with couplings in accordance with ASTM D3212 with loose banded, coupled, or push-on joints.

B. Join perforated PVC sewer pipe and fittings in accordance with ASTM D3212 with loose bell-and-spigot, push-on joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 INSTALLATION OF BACKWATER VALVES

A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping[**in manholes or pits**] where indicated.

3.10 INSTALLATION OF CLEANOUTS

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for [**Foundation**][**Retaining-Wall**][**and**][**Landscaping**] Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**18 by 18 by 12 inches (450 by 450 by 300 mm)**]<**Insert dimensions**> deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use **NPS 4 (DN 100)** [**cast-iron**][**PVC**] pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**12 by 12 by 4 inches (300 by 300 by 100 mm)**]<**Insert dimensions**> deep. Set top of cleanout [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**> above grade.
4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to[**building's**] solid-wall-piping storm drainage system.

C. Where required, connect low elevations of [**foundation**][**underslab**] subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."

1. Install PE warning tape or detectable warning tape over ferrous piping.
2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are

satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 33 46 00 00

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Task	Specification	Specification Description
33 46 23 00	33 46 00 00	Subdrainage
33 46 53 00	33 11 13 00a	Potable Water Supply Wells
33 46 53 00	33 46 00 00	Subdrainage

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SECTION 33 52 16 13 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. CSST and fittings.
3. Aluminum tubing, piping, and fittings.
4. Copper tubing and fittings.
5. PE pipe, tubing, and fittings.
6. Mechanical couplings.
7. Piping specialties.
8. Manual gas shutoff valve.
9. Manual gas shutoff ball valve.
10. Automatic gas shutoff valve.
11. Earthquake valve.
12. Pressure regulators.
13. Service meters.
14. Dielectric fittings.
15. Detectable warning tape.

B. Related Requirements:

1. Section 231126 "Facility Liquified-Petroleum Gas Piping."

1.2 DEFINITIONS

A. CSST: Corrugated stainless steel tubing.

B. CWP: Cold working pressure.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.

D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

F. PE: Polyethylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Provide plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: [**1/4 inch per foot (1:50)**]<**Insert scale**> .
2. Detail mounting, supports, and valve arrangements for [**service-meter assembly and**] pressure regulator assembly.

C. Delegated Design Submittals: Comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Seismic Qualification Data: Submit certification that vaporizer, air mixer, storage container supports, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Welding Certificates: For piping.

E. Field Quality Control Reports: For specified tests and inspections.

F. Qualification Statements: For professional engineer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**automatic gas shutoff valves**][**pressure regulators**][**and**][**service meters**] .

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with the ASME Boiler and

Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping in accordance with requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes, tubing, and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide purging and startup of natural-gas supply in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

C. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 230553 "Identification of HVAC Piping and Equipment."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with [**NFPA 54**][**and**][**the International Fuel Gas Code**] for natural-gas distribution system, including materials, installation, and testing.

B. Comply with requirements of authorities having jurisdiction.

C. Comply with requirements of utility company supplying natural-gas.

D. Minimum Operating-Pressure Ratings:

1. Piping and Valves: [**100 psig (690 kPa)**]<**Insert pressure**> minimum.
2. Service Regulators: [**65 psig (450 kPa)**][**100 psig (690 kPa)**]<**Insert pressure**> minimum.
3. Service Meter: [**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**20 psig (138 kPa)**][**65 psig (450 kPa)**]<**Insert value**> .

E. Natural-Gas System Pressure within Buildings:

1. Single Pressure: [**0.5 psig (3.45 kPa) or less**][**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**][**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**]<**Insert pressure range**> .
2. Two Pressure Ranges, Not More Than 2 psig (13.8 kPa): Primary pressure is more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)** and is reduced to secondary pressure of **0.5 psig (3.45 kPa)** or less.
3. Two Pressure Ranges, Not More Than 5 psig (34.5 kPa): Primary pressure is more than **2 psig (13.8 kPa)** but not more than **5 psig (34.5 kPa)** and is reduced to secondary pressure of more than **0.5 psig (3.45 kPa)**, but not more than **2 psig (13.8 kPa)**.
4. Three Pressure Ranges: Primary pressure is more than **2 psig (13.8 kPa)** but not more than **5 psig (34.5 kPa)** is reduced to secondary pressures of more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)** and is reduced again to pressures of **0.5 psig (3.45 kPa)** or less.

F. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Seismic Performance: Natural-gas piping system is to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**> . See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified [**and the piping system will be fully operational after the seismic event**] ."
2. Component Importance Factor: [**1.5**][**1.0**] .
3. Component Amplification Factor: <**Insert requirement**> .
4. Component Response Modification Factor: <**Insert requirement**> .

2.2 PIPE, TUBES, AND FITTINGS

A. Steel Pipe and Fittings:

1. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
3. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
5. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

a. Material Group: 1.1.
b. End Connections: Threaded or butt welding to match pipe.

c. Lapped Face: Unacceptable for underground.
d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

6. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. CSST and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**FlashShield Products; Gastite, a division of Titeflex Corp.**]
b. [**TracPipe CounterStrike; OmegaFlex, Inc.**]
c. [**Tru-Flex Metal Hose Corp**]
d. [**Ward Manufacturing LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**FlashShield Products; Gastite, a division of Titeflex Corp.**]
b. [**TracPipe CounterStrike; OmegaFlex, Inc.**]
c. [**Tru-Flex Metal Hose Corp**]
d. [**Ward Manufacturing LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitation: Obtain CSST and fittings from single manufacturer.
4. Standard: CSA/ANSI LC 1/CSA 6.26.
5. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
6. Jacket: Electrically insulative and UV-resistant polymer with flame retardant.

a. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 50 or less.

7. Jacket with Fully Vent-Capable PE Sleeve: Include associated fittings suitable for locations requiring vented containment.
8. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with CSST and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
9. Striker Plates: Steel, designed to protect tubing from penetrations.
10. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections are to comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
11. Operating-Pressure Rating: **5 psig (34.5 kPa)**.

C. Aluminum Tubing, Piping, and Fittings:

1. Aluminum Tubing and Piping:

a. Standards:

1) ASTM B210/B210M.
2) ASTM B241/B241M.

b. Material: Aluminum Alloy 5456 is prohibited by NFPA 54.

2. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
3. Flare Fittings: ASME B16.26 and SAE J513.

a. Copper-alloy fittings.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads complying with ASME B1.20.3.

D. Copper Tubing and Fittings:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B280, Type ACR**][**ASTM B837, Type G**] .
2. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B280, Type ACR**][**ASTM B837, Type G**] .
3. Coating: Factory-applied, extruded PE a minimum of **0.025 inch (0.64 mm)** thick. Continuously marked with size, specification information, manufacturing code, and footage every **2 ft. (610 mm)**.
4. Tin-Lined Copper Tube: ASTM B280, seamless, annealed, with interior tin-plated lining.
5. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
6. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.

a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.

7. Flare Fittings: Comply with ASME B16.26 and SAE J513.

a. Copper fittings with long nuts.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads complying with ASME B1.20.3.

8. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of **0.022 inch (0.56 mm)** thick.

E. PE Pipe, Tubing, and Fittings:

1. PE Pipe and Tubing: ASTM D2513, SDR 11.
2. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type.
3. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
4. Anodeless Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.

b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. [**Vent casing aboveground.**]
c. Aboveground Portion: PE transition fitting.
d. Provide outlet threaded or flanged or suitable for welded connection.
e. Provide tracer wire connection.
f. Provide UV shield.

5. Transition Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
b. Provide outlet threaded or flanged or suitable for welded connection.
c. Provide bridging sleeve over mechanical coupling.
d. Provide factory-connected anode.
e. Provide tracer wire connection.
f. Provide UV shield.

2.3 MECHANICAL COUPLINGS

A. Mechanical Coupling - Plastic, NPS 1-1/2 (DN 40) and Smaller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Continental Industries; brand of Hubbell Incorporated**]
b. [**Elster Perfection; Honeywell**]
c. [**Lyall; brand of Hubbell Incorporated**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Continental Industries; brand of Hubbell Incorporated**]
b. [**Elster Perfection; Honeywell**]
c. [**Lyall; brand of Hubbell Incorporated**]
d. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Standard: ASTM D2513.
5. PE body.
6. Elastomeric seals.
7. Independent gripping collets.
8. Suitable for joining PE pipe to PE pipe.

B. Mechanical Coupling - Plastic, NPS 2 (DN 50) and Larger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Elster Perfection; Honeywell**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Elster Perfection; Honeywell**]
b. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Standard: ASTM D2513.
5. Stainless steel bolts, nuts, and washers.
6. Suitable for joining PE pipe to PE pipe.

C. Mechanical Coupling - Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Smith-Blair, a Xylem brand.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Smith-Blair, a Xylem brand.**]
b. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Flanges and Tube: [**Stainless steel**][**Steel**] with epoxy finish.
5. Seals: NBR.
6. Bolts, Washers, and Nuts: [**Stainless steel**][**Steel**] bolts, washers, and nuts.
7. Factory-installed anode for steel-body couplings installed underground.
8. Suitable for joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

2.4 PIPING SPECIALTIES

A. Appliance Flexible Connector:

1. Indoor, Fixed-Appliance Flexible Connectors: ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: ANSI Z21.75.
4. CSST with polymer coating.
5. Operating-Pressure Rating: **0.5 psig (3.45 kPa)**.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: **72 inches (1830 mm)**.

B. Quick-Disconnect Device:

1. Standard: ANSI Z21.41/CSA 6.9.
2. Copper-alloy convenience outlet and matching plug connector.
3. Nitrile seals.
4. Hand operated with automatic shutoff when disconnected.
5. For indoor or outdoor applications.
6. Adjustable, retractable restraining cable.

C. Y-Pattern Strainer:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

D. Basket Strainer:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

E. T-Pattern Strainer:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer, and perforated stainless steel basket with 57 percent free area.
4. CWP Rating: **750 psig (5170 kPa)**.

F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.5 Steel Pressure-Seal Fittings

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.6 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: AWS D10.12/D10.12M.

C. Brazing Filler Metals: AWS A5.8/A5.8M alloy with melting point greater than **1000 deg F (540 deg C)**. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.7 GAS VALVES

A. Manual Gas Shutoff Valve - Metallic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**BrassCraft Manufacturing Co.; a Masco company**]
    d. [**Jenkins Valves; a Crane Co. brand**]
    e. [**Jomar Valve**]
    f. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
    g. [**NIBCO INC.**]
    h. [**Stockham; a Crane Co. brand**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**BrassCraft Manufacturing Co.; a Masco company**]
    d. [**Jenkins Valves; a Crane Co. brand**]
    e. [**Jomar Valve**]
    f. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
    g. [**NIBCO INC.**]
    h. [**Stockham; a Crane Co. brand**]
    i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain metallic manual gas shutoff valves from single manufacturer.
4. Description: Metallic ball valve or metallic plug valve of type indicated in schedules under Part 3.
5. Standards:

    a. CSA/ANSI Z21.15/CSA 9.1.
    b. ASME B16.33.
    c. ASME B16.44.

6. System Pressure Rating: [**0.5 psig (3.45 kPa) or less**][**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**][**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**][**More than 5 psig (34.5 kPa) but not more than 125 psig (862 kPa)**]<**Insert pressure**> .
7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service Mark: Initials "WOG" permanently marked on valve body.
9. End Connections:

    a. Threaded Ends: ASME B1.20.1.
    b. Dryseal Threads on Flare Ends: ASME B1.20.3.
    c. Flanged Ends: ASME B16.5 for steel flanges.

10. Tamperproof locking feature.

B. Manual Gas Shutoff Ball Valve - PE:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Elster Perfection; Honeywell**]
    b. [**Kerotest Manufacturing Corp**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elster Perfection; Honeywell**]
    b. [**Kerotest Manufacturing Corp**]
    c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain PE manual gas shutoff valves from single manufacturer.
4. Standard: ASME B16.40.
5. Body: PE.
6. Ball: Polypropylene.
7. Stem: Acetal.
8. Seats and Seals: NBR.
9. Ends: Plain or fusible to match piping.
10. CWP Rating: [**80 psig (552 kPa)**]<**Insert pressure**> .
11. Operating Temperature: [**Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C)**]<**Insert temperature range**> .
12. Operator: Nut or flat head for key operation.
13. Plastic valve extension.
14. Tamperproof locking feature.

C. Valve Box:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of **5 inches (125 mm)** in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

D. Automatic Gas Shutoff Valve - Electrically Operated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**American Gas Safety, LLC.**]
    b. [**ASCO; an Emerson company**]
    c. [**BASO Gas Products, LLC**]
    d. [**Magnatrol Valve Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**American Gas Safety, LLC.**]
b. [**ASCO; an Emerson company**]
c. [**BASO Gas Products, LLC**]
d. [**Magnatrol Valve Corporation**]
e. <**Insert manufacturer's name**>

3. Source Limitation: Obtain electrically operated automatic gas shutoff valves from single manufacturer.
4. Description: Electrically operated automatic valve, solenoid type, used in natural-gas piping for automatic shutoff of service when interlocked with a hazard-condition initiating device.
5. Standards:

a. CSA/ANSI Z21.21/CSA 6.5.
b. UL 429.
c. FM Global approved.

6. Body: Brass or aluminum.
7. Seats and Disc: NBR.
8. Springs and Valve Trim: Stainless steel.
9. Coil: Continuous-duty, molded coil, replaceable.
10. Normally closed.
11. Visual position indicator.
12. Electrical Characteristics: [**120 V ac, 60 Hz**][**24 V ac, 60 Hz**][**24 V dc**]<**Insert value**> .

E. Earthquake Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Firefighter Gas Safety Products**]
b. [**Pacific Seismic Products, Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Firefighter Gas Safety Products**]
b. [**Pacific Seismic Products, Inc**]
c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain earthquake valves from same manufacturer.
4. Description: Seismically activated automatic gas shutoff valve.
5. Standard: ANSI/ASCE/SEI 25.
6. Maximum Operating Pressure: [**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**60 psig (414 kPa)**]<**Insert pressure**> .
7. Sight windows for visual indication of valve position.
8. Threaded end connections complying with ASME B1.20.1.
9. Threaded for valves **NPS 4 (DN 100)** and smaller; or flanged for valves **NPS 2 (DN 50)** and larger.
10. Wall-mounting bracket with bubble level indicator.

2.8 PRESSURE REGULATORS

A. Service Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. [**Fairview Ltd.**]
   d. [**Fischer; Emerson Electric Co., Automation Solutions**]
   e. [**Marshall Excelsior Company**]
   f. [**Maxitrol Company**]
   g. [**RegO Products; a brand of Engineered Controls International, LLC**]
   h. [**Richards Industrials**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. [**Fairview Ltd.**]
   d. [**Fischer; Emerson Electric Co., Automation Solutions**]
   e. [**Marshall Excelsior Company**]
   f. [**Maxitrol Company**]
   g. [**RegO Products; a brand of Engineered Controls International, LLC**]
   h. [**Richards Industrials**]
   i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain service pressure regulators from single manufacturer.
4. Standards:

   a. NFPA 54.
   b. ANSI Z21.80/CSA 6.22.

5. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
6. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
7. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
8. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**20 psig (138 kPa)**]<**Insert pressure**> .
9. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

B. Line Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain line-pressure regulators from single manufacturer.
4. Standards:

a. NFPA 54.
b. CSA/ANSI Z21.80/CSA 6.22.

5. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
6. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
7. Maximum Inlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**][**10 psig (69 kPa)**]<**Insert pressure**> .
8. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**]<**Insert pressure**> .
9. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]

c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fairview Ltd.**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fairview Ltd.**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain appliance pressure regulators from single manufacturer.
4. Standards:

a. NFPA 54.
b. CSA/ANSI Z21.18/CSA 6.3.

5. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
6. Maximum Inlet Pressure: [**1 psig (6.9 kPa)**][**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**]<**Insert pressure**> .
7. Maximum Outlet Pressure: [**1 psig (6.9 kPa)**][**2 psig (13.8 kPa)**]<**Insert pressure**> .
8. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.

2.9 SERVICE METERS

A. Diaphragm-Type Service Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]

c. **<Insert manufacturer's name>**

3. Source Limitation: Obtain diaphragm-type service meters from single manufacturer.
4. Standard: [**ANSI B109.1**][**ANSI B109.2**] .
5. Case: Die-cast aluminum.
6. Connections: Steel threads.
7. Diaphragm: Synthetic fabric.
8. Diaphragm Support Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Meter Case and Index: Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Pressure Loss: Maximum [**0.5 inch wg (124 Pa)**][**2.0 inch wg (498 Pa)**]<**Insert pressure differential**> .
15. Accuracy: Maximum plus or minus [**1.0**]<**Insert number**> percent.

B. Rotary-Type Service Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain rotary-type service meters from single manufacturer.
4. Standard: ANSI B109.3.
5. Case: Extruded aluminum.
6. Connection: Flange.
7. Impellers: Polished aluminum.
8. Rotor Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Accuracy: Maximum plus or minus [**2.0**]<**Insert number**> percent.

C. Turbine Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain turbine meters from single manufacturer.
4. Standard: ASME MFC.4M.
5. Housing: Cast iron or welded steel.
6. Connection Threads or Flanges: Steel.
7. Turbine: Aluminum or plastic.
8. Turbine Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Accuracy: Maximum plus or minus [**2.0**]<**Insert number**> percent.

D. Service-Meter Bar:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
c. <**Insert manufacturer's name**>

3. Malleable- or cast-iron frame for supporting service meter.
4. Include offset swivel pipes, meter nuts with O-ring seal, and factory- or field-installed dielectric unions.
5. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

E. Service-Meter Bypass Fitting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A.Y. McDonald Mfg. Co.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. <**Insert manufacturer's name**>

3. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
4. Integral ball-check bypass valve.

2.10 DIELECTRIC FITTINGS

A. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Union:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A.Y. McDonald Mfg. Co.**]
b. [**HART Industrial Unions, LLC**]
c. [**Jomar Valve**]
d. [**Matco-Norca**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**HART Industrial Unions, LLC**]
c. [**Jomar Valve**]
d. [**Matco-Norca**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Standard: ASSE/IAMPO/ANSI/CAN 1079.
4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**250 psig (1725 kPa) minimum at 180 deg F (82 deg C)**]<**Insert pressure rating at temperature**> .
5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flange:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Matco-Norca**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Matco-Norca**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Standard: ASSE 1079.
4. Factory-fabricated, bolted, companion-flange assembly.
5. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**175 psig (1200 kPa) minimum at 180 deg F (82 deg C)**][**300 psig (2070 kPa) minimum at 180 deg F (82 deg C)**]<**Insert pressure at temperature**> .
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kit:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT Industries, LLC.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT Industries, LLC.**]
d. <**Insert manufacturer's name**>

3. Nonconducting materials for field assembly of companion flanges.
4. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**> .
5. Gasket: Neoprene or phenolic.
6. Bolt Sleeves: Phenolic or polyethylene.
7. Washers: Phenolic with steel backing washers.

2.11 DETECTABLE WARNING TAPE

A. Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping in accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction requirements for preventing accidental ignition.

3.4 INSTALLATION OF PIPE, TUBES, AND FITTINGS

A. Outdoor Piping: Comply with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction requirements for installation and purging of natural-gas piping.

1. Install underground, natural-gas piping buried at least [**18 inches (460 mm)**]<**Insert value**> below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

    a. If natural-gas piping is installed less than **12 inches (300 mm)** below finished grade, install it in containment conduit.

2. Install underground, PE, natural-gas piping in accordance with ASTM D2774.
3. Steel Piping with Protective Coating:

    a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
    b. Repair damage to PE coating on pipe as recommended in writing by protective coating

manufacturer.
c. Replace pipe having damaged PE coating with new pipe.

4. Copper Tubing with Protective Coating:

a. Apply joint cover kits over tubing to cover, seal, and protect joints.
b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

5. Install fittings for changes in direction and branch connections.
6. Joints for connection to inlets and outlets on regulators, and valves may be flanged or threaded to match the equipment.
7. Install pressure gauge [**downstream**][**upstream and downstream**] from each service regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

B. Indoor Piping: Comply with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction requirements for installation and purging of natural-gas piping.

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
3. Install piping in concealed locations unless otherwise indicated on Drawings. Piping in equipment rooms and service areas may be installed exposed. Piping is not to be installed in inaccessible locations.

a. Conceal piping in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
b. Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit in accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1) Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

a) Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

2) In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of **1-1/2 inches (38 mm)** of concrete. Piping may not be in physical contact with other metallic structures, such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3) In Floor Channels: Channels must have cover and be open to space above cover for ventilation.
4) In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

a) Exception: Tubing passing through partitions or walls does not require striker barriers.

5) Prohibited Locations:

a) Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
b) Do not install natural-gas piping in return-air plenums.
c) Do not install natural-gas piping in solid walls or partitions.

6) Under the Building: Install in vented containment conduit or CSST with integral vented sleeve and associated fittings.

4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise on Drawings.
5. Locate valves for easy access from a standing position. Do not locate valves within return air plenums.
6. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Comply with requirements in Sections specifying gas-fired appliances and equipment, and verify final appliance and equipment locations for roughing-in requirements.
10. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

    a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of three pipe diameters, but not less than **3 inches (75 mm)** long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
    b. Install sediment trap on both sides of regulators for gas reduction to **2 psig (13.8 kPa)** with valve and cap.

11. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors, and terminate with weatherproof vent cap.
12. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
13. Connect branch piping from top or side of horizontal piping.
14. Install unions in pipes **NPS 2 (DN 50)** and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
15. Do not use natural-gas piping as grounding electrode.
16. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve. Remove and replace startup strainer with new strainer prior to final acceptance tests.
17. Install pressure gauge [**downstream**][**upstream and downstream**] from each line regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."
18. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
19. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."
20. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.5 INSTALLATION OF SERVICE METERS

A. Install service-meter assemblies aboveground [**, on concrete bases**] .

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 INSTALLATION OF PRESSURE REGULATORS

A. Ensure the gas supply is completely shut off at the main valve and that the line is fully depressurized.

B. Remove any shipping plugs from the inlet, outlet, and vent connections. Ensure the pipe interior and regulator are free of dirt, debris, and contaminants.

C. Apply pipe joint sealant or Teflon tape rated for gas use to the male threads of the pipe. Avoid getting sealant on the female threads or inside the regulator.

D. Mount the regulator in the correct orientation, aligning the flow arrow on the body with the direction of gas flow. The piping must be properly aligned and supported to avoid stressing the regulator.

E. If the pressure regulator is installed inside of a building, install a dedicated vent line directly from the regulator to the outdoors. The vent terminal must be insect resistant and rain resistant. The regulator should be at least **3 ft. (914 mm)** horizontally from any building opening below the vent opening, and positioned so that gas can disperse freely.

3.7 INSTALLATION OF GAS VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of CSST, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

F. Do not install valves in return-air plenums.

3.8 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, and then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.9 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for [**steel piping**][**and**][**copper tubing**] , with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting.

F. Support vertical runs of [**steel piping**][**and**][**copper tubing**] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.10 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Install piping adjacent to appliances to allow space for service and maintenance of appliances.

D. Connect piping to appliances using manual gas-shutoff valves and unions. Install valve within **72 inches (1800 mm)** of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.11 INSTALLATION OF LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, **12 inches (300 mm)** below finished grade, except **6 inches (150 mm)** below subgrade under pavements and slabs.

C. Label and identify gas piping and pressure outside a multitenant building by tenant.

3.12 CONCRETE BASES

A. Anchor equipment to concrete base [.][**in accordance with seismic codes of Project. See Section 230548 "Vibration and Seismic Controls for HVAC."**]

B. Construct concrete bases of dimensions indicated, but not less than **4 inches (100 mm)** larger in both directions than supported unit.

C. Install dowel rods to connect concrete base to concrete floor. Install dowel rods on [**18-inch (450-mm)**]<**Insert dimension**> centers around the full perimeter of the base.

D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

F. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Use [**3000 psig (20.7 MPa)**]<**Insert value**> , 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Comply with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction requirements for testing, inspection, and purging of natural-gas installation.
2. Natural-gas installation will be considered defective if it does not pass tests and inspections. Defective products are to be replaced. Retest installation after defective products have been replaced for code compliance.

B. Prepare test and inspection reports.

3.14 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.15 OUTDOOR NATURAL-GAS PIPING SCHEDULE

A. Underground Natural-Gas Piping: To be one of the following:

1. PE Pipe, Tubing and Fittings: Terminate service-line risers with tracer wire in an accessible location.
2. Steel Pipe: With wrought-steel welding fittings or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
3. Drawn-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
4. Annealed-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
5. Containment Conduit: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.
6. CSST and Fittings: With integral vented sleeve terminated in an accessible location.

B. Aboveground Natural-Gas Piping: To be one of the following:

1. CSST and fittings.
2. Steel pipe with malleable-iron threaded fittings.
3. Steel pipe with wrought-steel welded fittings.
4. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
5. Annealed-Temper Copper Tube: With wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

3.16 INDOOR NATURAL-GAS PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground Branch Piping NPS 1 (DN 25) and Smaller: To be one of the following:

1. CSST and fittings.
2. Tin-Lined Copper Tube: With flared joints and fittings.
3. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints.

4. Aluminum Tube: With flared fittings and joints.
5. Steel Pipe: With malleable-iron threaded fittings.

B. Aboveground Distribution Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

C. Underground Below-Building Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Containment Conduit: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.
4. Containment Conduit Vent Piping: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.

3.17 INDOOR NATURAL-GAS PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground Branch Piping NPS 1 (DN 25) and Smaller: To be one of the following:

1. CSST and fittings.
2. Tin-Lined Copper Tube: With flared joints and fittings.
3. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints.
4. Aluminum Tubing and Piping: With flared fittings and joints.
5. Steel Pipe: With malleable-iron threaded fittings.

B. Aboveground Distribution Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

C. Underground Below-Building Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Containment Conduit: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.
4. Containment Conduit Vent Piping: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.

3.18 INDOOR NATURAL-GAS PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: Maximum operating pressure more than [**5 psig (34.5 kPa)**]<**Insert pressure**> .

B. Aboveground, Branch Piping:

1. Steel Pipe: With wrought-steel welding fittings.

C. Aboveground Distribution Piping: To be one of the following:

1. Steel Pipe: With wrought-steel welding fittings.
2. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

D. Underground Below-Building Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Containment Conduit: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.
4. Containment Conduit Vent Piping: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.

3.19 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground:

1. Manual gas shutoff ball valve - PE.
2. Manual gas shutoff valve - metallic.

3.20 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Aboveground Natural-Gas Piping: Manual gas shutoff valve - metallic.

END OF SECTION 33 52 16 13

SECTION 33 52 16 13A - FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. CSST and fittings.
3. Aluminum tubing, piping, and fittings.
4. Copper tubing and fittings.
5. PE pipe, tubing, and fittings.
6. Polyamide pipe, tubing, and fittings.
7. Mechanical couplings.
8. Piping specialties.
9. Manual gas shutoff valve.
10. Manual gas shutoff ball valve.
11. Valve boxes.
12. Automatic gas shutoff valve.
13. Earthquake valve.
14. Pressure regulators.
15. Service meters.
16. Dielectric fittings.
17. Storage containers.
18. Transport truck unloading facility.
19. Vaporizers.
20. Detectable warning tape.

B. Related Requirements:

1. Section 231123 Facility Natural-Gas Piping.

1.2 DEFINITIONS

A. CSST: Corrugated stainless steel tubing.

B. CWP: Cold working pressure.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

F. LPG: Liquefied-petroleum gas.

G. PE: Polyethylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Provide plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawings Scale: [**1/4 inch per foot (1:50)**]<**Insert scale**> .
2. Detail mounting, supports, and valve arrangements for [**service meter assembly and**] pressure regulator assembly.

C. Delegated Design Submittals: Comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which LPG piping is indicated and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which LPG piping is shown and coordinated with other services and utilities.

C. Seismic Qualification Data: Submit certification that vaporizer, air mixer, storage container supports, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Welding Certificates: For piping.

E. Field Quality Control Reports: For specified tests and inspections.

F. Qualification Statements: For professional engineer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**automatic gas shutoff valves**][**pressure regulators**][**and**][**service meters**] .

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping in accordance with requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes with factory-applied protective coating to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes, tubing, and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing LPG Service: Do not interrupt LPG service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of LPG supply in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of LPG service.
2. Do not proceed with interruption of LPG service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

C. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 230553 "Identification of HVAC Piping and Equipment."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with requirements of [**NFPA 58**][**and**][**the International Fuel Gas Code**] for LPG distribution

system, including materials, installation, and testing.

B. Comply with requirements of authorities having jurisdiction.

C. Comply with requirements of utility company supplying LPG.

D. Minimum Operating-Pressure Ratings:

1. Piping and Valves: [**125 psig (862 kPa)**]<**Insert pressure**> minimum.
2. Service Regulators: [**65 psig (450 kPa)**][**100 psig (690 kPa)**]<**Insert pressure**> minimum.
3. Service Meter: [**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**20 psig (138 kPa)**][**65 psig (450 kPa)**]<**Insert pressure**> .

E. LPG System Pressure within Buildings:

1. Single Pressure: [**0.5 psig (3.45 kPa) or less**][**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**][**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**]<**Insert pressure range**> .
2. Two Pressure Ranges, Not More Than 2 psig (13.8 kPa): Primary pressure is more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)** and is reduced to secondary pressure of **0.5 psig (3.45 kPa)** or less.
3. Two Pressure Ranges, Not More Than 5 psig (34.5 kPa): Primary pressure is more than **2 psig (13.8 kPa)** but not more than **5 psig (34.5 kPa)** and is reduced to secondary pressure of more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)**.
4. Three Pressure Ranges: Primary pressure is more than **2 psig (13.8 kPa)** but not more than **5 psig (34.5 kPa)**, is reduced to secondary pressures of more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)** and is reduced again to pressures of **0.5 psig (3.45 kPa)** or less.

F. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. Seismic Performance: LPG piping system, vaporizers, and storage container supports are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**> . See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. The term "withstand" means "the piping/unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [**and the piping system will be fully operational after the seismic event**] ."
2. Component Importance Factor: [**1.5**][**1.0**] .
3. Component Amplification Factor: <**Insert requirement**>
4. Component Response Modification Factor: <**Insert requirement**>

2.2 PIPE, TUBING, AND FITTINGS

A. Steel Pipe and Fittings:

1. Steel Pipe: ASTM A53/A53M black steel, Schedules 40 and 80, Type E or S, Grade B.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
3. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and

threaded ends.

5. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Unacceptable for underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground, and stainless steel underground.

6. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. CSST and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**FlashShield Products; Gastite, a division of Titeflex Corp.**]
    b. [**TracPipe CounterStrike; OmegaFlex, Inc.**]
    c. [**Tru-Flex Metal Hose Corp**]
    d. [**Ward Manufacturing LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**FlashShield Products; Gastite, a division of Titeflex Corp.**]
    b. [**TracPipe CounterStrike; OmegaFlex, Inc.**]
    c. [**Tru-Flex Metal Hose Corp**]
    d. [**Ward Manufacturing LLC**]
    e. <**Insert manufacturer's name**>

3. Source Limitation: Obtain CSST and fittings from single manufacturer.
4. Standard: CSA/ANSI LC 1/CSA 6.26.
5. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
6. Jacket: Electrically Insulative and UV-Resistant Polymer with Flame Retardant.

    a. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.

7. Jacket with Fully Vent-Capable PE Sleeve: Include associated fittings suitable for locations requiring vented containment.
8. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with CSST and suitable for metal-to-metal seal without gaskets. Include brazing socket or threaded ends

complying with ASME B1.20.1.
9. Striker Plates: Steel, designed to protect tubing from penetrations.
10. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections are to comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
11. Operating-Pressure Rating: **5 psig (34.5 kPa)**.

C. Aluminum Tubing, Piping, and Fittings:

1. Aluminum Tubing:

a. Standards:

1) ASTM B210/B210M.
2) ASTM B241/B241M.

b. Material: Aluminum Alloy 5456 is prohibited per NFPA 54.

2. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
3. Flare Fittings: Comply with ASME B16.26 and SAE J513.

a. Copper-alloy fittings.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads are to comply with ASME B1.20.3.

D. Copper Tubing and Fittings:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B280, Type ACR**][**ASTM B837, Type G**] .
2. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B280, Type ACR**][**ASTM B837, Type G**] .
3. Coating: Factory-applied, extruded PE a minimum of **0.025 inch (0.64 mm)** thick. Continuously marked with size, specification information, manufacturing code, and footage every **2 ft. (610 mm)**.
4. Tin-Lined Copper Tube: ASTM B280, seamless, annealed, with interior tin-plated lining.
5. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
6. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.

a. Gasket Material: ASME B16.20, metallic, flat, asbestos-free, aluminum o-rings and spiral-wound metal gaskets.
b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.

7. Flare Fittings: ASME B16.26 and SAE J513.

a. Copper fittings with long nuts.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads complying with ASME B1.20.3.

8. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of **0.022 inch (0.56 mm)** thick.

E. PE Pipe, Tubing, and Fittings:

1. PE Pipe and Tubing: ASTM D2513, SDR 11.
2. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type.

3. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11, and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
4. Anodeless Service-Line Riser: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering. [**Vent casing aboveground.**]
    c. Aboveground Portion: PE transition fitting.
    d. Provide outlet threaded or flanged or suitable for welded connection.
    e. Provide tracer wire connection.
    f. Provide UV shield.

5. Transition Service-Line Riser: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Provide outlet threaded or flanged or suitable for welded connection.
    c. Provide bridging sleeve over mechanical coupling.
    d. Provide factory-connected anode.
    e. Provide tracer wire connection.
    f. Provide UV shield.

F. Polyamide Pipe, Tubing, and Fittings: ASTM F2945.

2.3 MECHANICAL COUPLINGS

A. Mechanical Coupling - Plastic, NPS 1-1/2 (DN 40) and Smaller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Continental Industries; brand of Hubbell Incorporated**]
    b. [**Elster Perfection; Honeywell**]
    c. [**Lyall; brand of Hubbell Incorporated**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Continental Industries; brand of Hubbell Incorporated**]
    b. [**Elster Perfection; Honeywell**]
    c. [**Lyall; brand of Hubbell Incorporated**]
    d. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Standard: ASTM D2513.
5. PE body.
6. Elastomeric seals.
7. Independent gripping collets.
8. Couplings are to be suitable for joining PE pipe to PE pipe.

B. Mechanical Coupling - Plastic, NPS 2 (DN 50) and Larger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Elster Perfection; Honeywell**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Elster Perfection; Honeywell**]
   b. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Standard: ASTM D2513.
5. Stainless steel bolts, nuts, and washers.
6. Couplings are to be suitable for joining PE pipe to PE pipe.

C. Mechanical Coupling - Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Smith-Blair, a Xylem brand.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Smith-Blair, a Xylem brand.**]
   b. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Flanges and Tube: [**Stainless steel**][**Steel**] with epoxy finish.
5. Seals: NBR.
6. Bolts, Washers, and Nuts: [**Stainless steel**][**Steel**] bolts, washers, and nuts.
7. Factory-installed anode for steel-body couplings installed underground.
8. Suitable for joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

2.4 PIPING SPECIALTIES

A. Flexible Piping Joint:

1. Approved for LPG service.
2. Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. Minimum working pressure of **250 psig (1723 kPa)** and **250 deg F (121 deg C)** operating temperature.

4. Flanged- or threaded-end connections to match equipment connected and to be capable of minimum **3/4-inch (20-mm)** misalignment.
5. Maximum **36-inch (914-mm)** length for liquid LPG lines.

B. Appliance Flexible Connector:

1. Indoor, Fixed-Appliance Flexible Connectors: CSA/ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: CSA/ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: CSA/ANSI Z21.75.
4. CSST with polymer coating.
5. Operating-Pressure Rating: **0.5 psig (3.45 kPa)**.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: ASME B1.20.1.
8. Maximum Length: **72 inches (1830 mm)**.

C. Quick-Disconnect Device:

1. Standard: CSA/ANSI Z21.41/CSA 6.9.
2. Copper-alloy convenience outlet and matching plug connector.
3. Nitrile seals.
4. Hand operated with automatic shutoff when disconnected.
5. For indoor or outdoor applications.
6. Adjustable, retractable restraining cable.

D. Y-Pattern Strainer:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

E. Basket Strainer:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

F. T-Pattern Strainer:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer and perforated stainless steel basket with 57 percent free area.
4. CWP Rating: **750 psig (5170 kPa)**.

G. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.5 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for LPG.

B. Welding Filler Metals: AWS D10.12/D10.12M.

C. Brazing Filler Metals: AWS A5.8/A5.8M alloy with melting point greater than **1000 deg F (540 deg C)**. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.6 GAS VALVES

A. Manual Gas Shutoff Valve - Metallic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**BrassCraft Manufacturing Co.; a Masco company**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**Jomar Valve**]
   f. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   g. [**NIBCO INC.**]
   h. [**Stockham; a Crane Co. brand**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**BrassCraft Manufacturing Co.; a Masco company**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**Jomar Valve**]
   f. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   g. [**NIBCO INC.**]
   h. [**Stockham; a Crane Co. brand**]
   i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain metallic manual gas shutoff valves from single manufacturer.
4. Description: Metallic ball valve or metallic plug valve of type indicated in schedules under Part 3.
5. Standards:

   a. CSA/ANSI Z21.15/CSA 9.1.
   b. ASME B16.33.
   c. ASME B16.44.

6. System Pressure Rating: [**0.5 psig (3.45 kPa) or less**][**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**][**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**][**More than 5 psig (34.5 kPa) but not more than 125 psig (862 kPa)**]<**Insert pressure**> .
7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.

8. Service Mark: Initials "WOG" permanently marked on valve body.
9. End Connections:

    a. Threaded Ends: ASME B1.20.1.
    b. Dryseal Threads on Flare Ends: ASME B1.20.3.
    c. Flanged Ends: ASME B16.5 for steel flanges.

10. Tamperproof locking feature.

B. Manual Gas Shutoff Ball Valve - PE:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Elster Perfection; Honeywell**]
    b. [**Kerotest Manufacturing Corp**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elster Perfection; Honeywell**]
    b. [**Kerotest Manufacturing Corp**]
    c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain PE manual gas shutoff valves from single manufacturer.
4. Standard: ASME B16.40.
5. Body: PE.
6. Ball: Polypropylene.
7. Stem: Acetal.
8. Seats and Seals: NBR.
9. Ends: Plain or fusible to match piping.
10. CWP Rating: [**80 psig (552 kPa)**]<**Insert pressure**> .
11. Operating Temperature: [**Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C)**]<**Insert temperature range**> .
12. Operator: Nut or flat head for key operation.
13. Plastic valve extension.
14. Tamperproof locking feature.

C. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of **5 inches (125 mm)** in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

D. Automatic Gas Shutoff Valve - Hydrostatic Relief:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Fischer; Emerson Electric Co., Automation Solutions**]
b. [**Marshall Excelsior Company**]
c. [**RegO Products; a brand of Engineered Controls International, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fischer; Emerson Electric Co., Automation Solutions**]
b. [**Marshall Excelsior Company**]
c. [**RegO Products; a brand of Engineered Controls International, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitation: Obtain hydrostatic relief valves from single manufacturer.
4. Standard: NFPA 58.
5. Operating Pressure: [**350 psig (2413 kPa)**]<**Insert pressure**> .
6. Body: Brass.
7. Spring: Stainless steel.
8. Disc and Seat: NBR.
9. Brass body and stainless steel, spring-operated valve with resilient rubber disc seat and protective cap.
10. Factory set and tested.
11. Valve is to automatically reseat after relieving pressure.

E. Automatic Gas Shutoff Valve - Electrically Operated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gas Safety, LLC.**]
b. [**ASCO; an Emerson company**]
c. [**BASO Gas Products, LLC**]
d. [**Magnatrol Valve Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gas Safety, LLC.**]
b. [**ASCO; an Emerson company**]
c. [**BASO Gas Products, LLC**]
d. [**Magnatrol Valve Corporation**]
e. <**Insert manufacturer's name**>

3. Source Limitation: Obtain electrically operated automatic gas shutoff valves from single manufacturer.
4. Description: Electrically operated automatic valve, solenoid type, used in LPG piping for automatic shutoff of service when interlocked with a hazard-condition initiating device.

5. Standards:

    a. CSA/ANSI Z21.21/CSA 6.5.
    b. UL 429.
    c. FM Global approved.

6. Body: Brass or aluminum.
7. Seats and Disc: NBR.
8. Springs and Valve Trim: Stainless steel.
9. Coil: Continuous-duty, molded enclosure, replaceable.
10. Normally closed.
11. Visual position indicator.
12. Electrical Characteristics: [**120 V ac, 60 Hz**][**24 V ac, 60 Hz**][**24 V dc**]<**Insert value**> .

F. Earthquake Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Firefighter Gas Safety Products**]
    b. [**Pacific Seismic Products, Inc**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Firefighter Gas Safety Products**]
    b. [**Pacific Seismic Products, Inc**]
    c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain earthquake valves from single manufacturer.
4. Description: Seismically activated automatic gas shutoff valve.
5. Standard: ANSI/ASCE/SEI 25.
6. Maximum Operating Pressure: [**10 psig (69 kPa)**][**60 psig (414 kPa)**]<**Insert pressure**> .
7. Sight windows for visual indication of valve position.
8. Threaded end connections complying with ASME B1.20.1.
9. Threaded for valves **NPS 4 (DN 100)** and smaller; or flanged for valves **NPS 2 (DN 50)** and larger.
10. Wall-mounting bracket with bubble level indicator.

2.7 PRESSURE REGULATORS

A. Service Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Cavagna North America**]
    b. [**Dresser Utility Solutions**]
    c. [**Elster-American Meter**]

d. [**Fairview Ltd.**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. [**Richards Industrials**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cavagna North America**]
b. [**Dresser Utility Solutions**]
c. [**Elster-American Meter**]
d. [**Fairview Ltd.**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. [**Richards Industrials**]
j. <**Insert manufacturer's name**>

3. Source Limitation: Obtain service pressure regulators from single manufacturer.
4. Standards:

a. NFPA 58.
b. CSA/ANSI Z21.80/CSA 6.22.

5. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure-sensing piping external to the regulator.
6. Pressure regulator is to maintain discharge pressure-setting downstream and is not to exceed 150 percent of design discharge pressure at shutoff.
7. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
8. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**20 psig (138 kPa)**]<**Insert pressure**> .
9. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

B. Line-Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]

g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain line-pressure regulators from single manufacturer.
4. Standards:

a. NFPA 58.
b. CSA/ANSI Z21.80/CSA 6.22.

5. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure-sensing piping external to the regulator.
6. Pressure regulator is to maintain discharge pressure-setting downstream and is not exceed 150 percent of design discharge pressure at shutoff.
7. Maximum Inlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**][**10 psig (69 kPa)**]<**Insert pressure**> .
8. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**]<**Insert pressure**> .
9. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fairview Ltd.**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fairview Ltd.**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain appliance pressure regulators from single manufacturer.
4. Standards:

a. NFPA 58.
b. CSA/ANSI Z21.18/CSA 6.3.

5. Regulator may include vent-limiting device, instead of vent connection, if approved by authorities having jurisdiction.
6. Maximum Inlet Pressure: [**1 psig (6.9 kPa)**][**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**]<**Insert pressure**> .
7. Maximum Outlet Pressure: [**1 psig (6.9 kPa)**][**2 psig (13.8 kPa)**]<**Insert pressure**> .
8. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.

2.8 SERVICE METERS

A. Diaphragm-Type Service Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain diaphragm-type service meters from single manufacturer.
4. Standard: [**ANSI B109.1**][**ANSI B109.2**] .
5. Case: Die-cast aluminum.
6. Connections: Steel threads.
7. Diaphragm: Synthetic fabric.
8. Diaphragm Support Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .

10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Meter Case and Index: Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Pressure Loss: Maximum [**0.5 inch wg (124 Pa)**][**2.0 inch wg (498 Pa)**]<**Insert pressure differential**> .
15. Accuracy: Maximum plus or minus [**1.0**]<**Insert number**> percent.

B. Rotary-Type Service Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Dresser Utility Solutions**]
    b. [**Elster-American Meter**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Dresser Utility Solutions**]
    b. [**Elster-American Meter**]
    c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain rotary-type service meters from single manufacturer.
4. Standard: ANSI B109.3.
5. Case: Extruded aluminum.
6. Connection: Flange.
7. Impellers: Polished aluminum.
8. Rotor Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Accuracy: Maximum plus or minus [**2.0**]<**Insert number**> percent.

C. Turbine Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Dresser Utility Solutions**]
    b. [**Elster-American Meter**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Dresser Utility Solutions**]

b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain turbine meters from single manufacturer.
4. Standard: ASME MFC.4M.
5. Housing: Cast iron or welded steel.
6. Connection Threads or Flanges: Steel.
7. Turbine: Aluminum or plastic.
8. Turbine Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Accuracy: Maximum plus or minus [**2.0**]<**Insert number**> percent.

D. Service-Meter Bar:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   c. <**Insert manufacturer's name**>

3. Malleable- or cast-iron frame for supporting service meter.
4. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
5. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

E. Service-Meter Bypass Fitting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]

b. <**Insert manufacturer's name**>

3. Ferrous, tee, pipe fitting with capped side inlet for temporary LPG supply.
4. Integral ball-check bypass valve.

2.9 DIELECTRIC FITTINGS

A. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Union:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**HART Industrial Unions, LLC**]
   c. [**Jomar Valve**]
   d. [**Matco-Norca**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**HART Industrial Unions, LLC**]
   c. [**Jomar Valve**]
   d. [**Matco-Norca**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. <**Insert manufacturer's name**>

3. Standard: ASSE/IAMPO/ANSI/CAN 1079.
4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**250 psig (1725 kPa) minimum at 180 deg F (82 deg C)**]<**Insert pressure rating at temperature**> .
5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flange:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Matco-Norca**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Matco-Norca**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. [**Zurn Industries, LLC**]
    d. <**Insert manufacturer's name**>

3. Standard: ASSE/IAMPO/ANSI/CAN 1079.
4. Factory-fabricated, bolted, companion-flange assembly.
5. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**175 psig (1200 kPa) minimum at 180 deg F (82 deg C)**][**300 psig (2070 kPa) minimum at 250 deg F (282 deg C)**]<**Insert pressure**> .
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kit:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Advance Products & Systems, LLC**]
    b. [**CALPICO, Inc.**]
    c. [**GPT Industries, LLC.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advance Products & Systems, LLC**]
    b. [**CALPICO, Inc.**]
    c. [**GPT Industries, LLC.**]
    d. <**Insert manufacturer's name**>

3. Nonconducting materials for field assembly of companion flanges.
4. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**> .
5. Gasket: Neoprene or phenolic.
6. Bolt Sleeves: Phenolic or PE.
7. Washers: Phenolic with steel backing washers.

2.10 STORAGE CONTAINERS

A. Storage Container:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Roy E. Hanson Jr. Mfg.**]

b. [**TransTech Energy, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Roy E. Hanson Jr. Mfg.**]
   b. [**TransTech Energy, LLC**]
   c. <**Insert manufacturer's name**>

3. Description: Factory-designed, -fabricated, and -tested container.
4. Standards:

   a. NFPA 58.
   b. ASME BPVC-VIII-1.
   c. ANSI/CAN/UL/ULC 125.
   d. ANSI/CAN/UL/ULC 842.
   e. Department of Transportation (DOT) Regulations.
   f. Provide all appurtenances as required by NFPA 58, qualified to ANSI/CAN/UL/ULC 125.
   g. Vapor-shutoff valve.
   h. Liquid-shutoff valve.
   i. Pressure-relief valve.
   j. Fixed maximum liquid level gauge.
   k. Filler valve.
   l. Overfilling protection device.
   m. Actuated liquid withdrawal excess-flow valve.
   n. Provide container appurtenances with a minimum service pressure rating of **250 psig (1724 kPa)**.

5. Provide exposed metal surfaces mechanically cleaned, primed, and painted for resistance to corrosion for outdoor installation.
6. Provide ladders for access to valves more than **72 inches (1830 mm)** aboveground.
7. Stainless Steel Nameplate: Attach to aboveground storage container or to adjacent structure for underground storage container.

   a. Name and address of supplier or trade name of container.
   b. Water capacity in gallons and liters.
   c. Design pressure in psig and kPa.

      1) Statement: "This container does not contain a product having a vapor pressure in excess of <**Insert maximum pressure in psig (kPa) at 100 deg F (37.8 deg C)**> ."
      2) Outside surface area in square feet and square meters.
      3) Year of manufacture.
      4) Shell thickness in inches and millimeters.
      5) Overall length in feet and meters.
      6) OD in feet and meters.
      7) Manufacturer's serial number.
      8) ASME code label.

   d. Felt support pads and two concrete or painted-steel saddles per storage container. Corrosion protection required at container-to-felt contact.
   e. Tie straps for each saddle.
   f. Straps and anchors for tie-down slab.
   g. Asphalt-based coating for corrosion protection.
   h. Container connections and valves protected in manway at top of storage container.

i. Manway equipped with ventilation louvers.

2.11 TRANSPORT TRUCK UNLOADING FACILITY

A. Transport Truck Unloading Facility: Provide in accordance with the requirements in NFPA 58.

1. Support structure consisting of a minimum **6-inch (150-mm)** steel channel or **6-by-4-inch (150-by-100-mm)** rectangular steel tubing, a minimum of **36 inches (914 mm)** above and below grade.
2. Liquid-fill and vapor-return, quick-disconnect fittings.
3. Liquid- and vapor-shutoff valves with hydrostatic relief valves mounted between the quick-disconnect fittings and shutoff valves.
4. Excess-flow safety shutoff valve in vapor-return line.
5. Backflow check valve in liquid-fill line.
6. Remote emergency shutoff valve station with underground cable to the vapor emergency shutoff valve.

2.12 VAPORIZERS

A. Vaporizer - Direct-Type, Direct-Fired Heat Exchanger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Algas-SDI**]
   b. [**Ransome Manufacturing**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Algas-SDI**]
   b. [**Ransome Manufacturing**]
   c. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizer.
4. Standards:

   a. NFPA 58.
   b. ASME BPVC-VIII-1.
   c. NFPA 70.
   d. FM Global labeled.

5. ASME-Rated and -Stamped: LPG vaporizer coil contained in an insulated enclosure insulated with a burner.
6. Burner Tubes and Orifices: Stainless steel.
7. Gas Train: Control devices and burner-control sequence are to be FM Global labeled. Provide shutoff valve, high- and low-pressure safety switches, pressure regulator, and main- and pilot-control valves.
8. Burner Operating Controls:

a. Controls are to maintain safe operating conditions.
b. High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design pressure.
c. Operating Vapor-Pressure Control: Factory piped and mounted to control burner.

B. Vaporizer - Indirect-Type, Direct-Fired Heat Exchanger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Algas-SDI**]
b. [**Ransome Manufacturing**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Algas-SDI**]
b. [**Ransome Manufacturing**]
c. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizer.
4. Standards:

a. NFPA 58.
b. ASME BPVC-VIII-1.
c. NFPA 70.
d. FM Global labeled.

5. ASME-Rated and -Stamped: LPG vaporizer vessel with a replaceable, immersion-type, electric heating element.
6. Heating Element Operating Controls:

a. Controls are to maintain safe operating conditions.
b. Operating Vapor-Pressure Control: Factory wired and mounted to control heating element.
c. High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design pressure.
d. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; is to sound alarm for out-of-normal conditions.
e. Control Transformer: 115 V maximum control voltage.

C. Vaporizer - Direct-Type, Water-Bath Heat Exchanger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Algas-SDI**]
b. [**Alternate Energy Systems, Inc**]
c. [**Ransome Manufacturing**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Algas-SDI**]
    b. [**Alternate Energy Systems, Inc**]
    c. [**Ransome Manufacturing**]
    d. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizer.
4. Standards:

    a. NFPA 58.
    b. ASME BPVC-VIII-1.
    c. NFPA 70.
    d. FM Global labeled.

5. ASME-Rated and -Stamped: Helical LPG vaporizer coil submerged in water bath. Straight, steel fire tubes welded into steel headers.
6. Water Bath:

    a. Water bath filled with water/glycol solution designed to prevent freezing at [**minus 30 deg F (minus 34 deg C)**]<**Insert temperature**> .
    b. Water-bath, high- and low-level sight glasses.
    c. Low-water cutoff to stop burner and annunciate alarm.
    d. Water/glycol fill and vent fitting.
    e. Minimum **NPS 3/4 (DN 20)** hose-end drain valves.
    f. Operating high- and low-limit aquastat controllers.
    g. Water-bath temperature gauge; a minimum of **2-1/2 inches (63 mm)** in diameter. Gauges are to have operating-temperature ranges, so normal operating range is at approximately 50 percent of full range.

7. Burner Tubes and Orifices: Stainless steel.
8. Gas Train: Control devices and burner-modulation control sequence is to be FM Global labeled. Provide shutoff valve, high- and low-pressure safety switches, pressure regulator, and main- and pilot-control valves.
9. Burner Operating Controls:

    a. Operating controls are to maintain safe operating conditions.
    b. Operating Water-Bath Temperature Control: Factory wired and mounted to control burner.
    c. High-Temperature and High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design temperature or vapor pressure.
    d. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; is to sound alarm for out-of-normal conditions.
    e. Control Transformer: 115 V maximum control voltage.

D. Vaporizer - Indirect-Type, Heat Exchanger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Algas-SDI**]
    b. [**Alternate Energy Systems, Inc**]

c. [**Ransome Manufacturing**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Algas-SDI**]
b. [**Alternate Energy Systems, Inc**]
c. [**Ransome Manufacturing**]
d. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizer.
4. Standards:

a. NFPA 58.
b. ASME BPVC-VIII-1.
c. NFPA 70.
d. FM Global labeled.

5. ASME-Rated and -Stamped: LPG vaporizer with immersion tubes containing [**steam**][**hot water**] and LPG in surrounding shell.
6. Operating Controls:

a. Controls are to maintain safe operating conditions.
b. High-Temperature and High-Pressure Cutoff: Manual reset if operating conditions rise above maximum design temperature or pressure.
c. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; sound alarm for out-of-normal conditions.
d. Control Transformer: 115 V maximum control voltage.

E. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control set points and display vaporizer status and alarms.

F. Capacities and Characteristics:

1. Heating Fuel: [**Propane**][**Butane**][**Electric**] .
2. Vaporization Heat Exchanger:

a. Minimum Working-Pressure Rating: [**250 psig (1723 kPa)**]<**Insert value**> .
b. Test Pressure: [**375 psig (2586 kPa)**]<**Insert value**> .

3. LPG Vaporization Rate: <**Insert gph (mL/s)**> .
4. Entering-LPG Temperature: [**Minus 30 deg F (Minus 34 deg C)**]<**Insert temperature**> .
5. Leaving-LPG Temperature: [**80 deg F (26.7 deg C)**]<**Insert temperature**> .
6. Discharge-LPG Pressure: [**90 psig (621 kPa)**]<**Insert value**> .
7. Burner Gas Input: <**Insert Btu/h (kW)**> .
8. Electric Burner Input: <**Insert kilowatts**> .
9. Water-Bath Vaporizers:

a. Operating Pressure: [**Atmospheric**]<**Insert psig (kPa)**> .
b. Operating Temperature: [**160 deg F (71 deg C)**]<**Insert temperature**> .

10. Electrical Characteristics:

a. Volts: [**120**][**240**][**480**]<**Insert number**> V.

b. Phase: [**Single**][**Three**] .
c. Hertz: 60.
d. Minimum Circuit Ampacity: <**Insert number**> A.
e. Maximum Overcurrent Protection: <**Insert number**> A.

2.13 DETECTABLE WARNING TAPE

A. Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment-shutoff valves before turning off LPG to premises or piping section.

B. Inspect LPG piping in accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction to determine that LPG utilization devices are turned off in piping section affected.

C. Comply with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction for prevention of accidental ignition.

3.4 INSTALLATION OF PIPE, TUBING, AND FITTINGS

A. Outdoor Pipe:

1. Comply with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction for installation and purging of LPG piping.
2. Install underground, LPG piping buried a minimum of [**12 inches (300 mm)**]<**Insert dimension**> below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

a. If LPG piping is installed less than **12 inches (300 mm)** below finished grade, install it in

containment conduit.

3. Install underground, PE, natural-gas piping in accordance with ASTM D2774.
4. Steel Piping with Protective Coating:

    a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
    b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
    c. Replace pipe having damaged PE coating with new pipe.

B. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Install fittings for changes in direction and branch connections.
4. Joints for connection to inlets and outlets on vaporizers, regulators, and valves may be flanged or threaded to match the equipment.
5. Install pressure gauge [**downstream**][**upstream and downstream**] from each service regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

C. Indoor Pipe:

1. Comply with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction for installation and purging of LPG piping.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
3. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
4. Install piping in concealed locations unless otherwise indicated on Drawings. Piping in equipment rooms and service areas may be installed exposed. Piping is not to be installed in inaccessible locations.

    a. Conceal piping in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
    b. Except as specified below, install concealed piping and piping installed under the building in containment conduit in accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

        1) Above Accessible Ceilings: Piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

            a) Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

        2) In Floors: Install piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of **1-1/2 inches (38 mm)** of concrete. Piping may not be in physical contact with other metallic structures, such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
        3) In Floor Channels: Channels must have cover and be open to space above cover for ventilation.
        4) In Walls or Partitions: Protect piping installed inside partitions or hollow walls from

physical damage using steel striker barriers at rigid supports.

a) Exception: Piping passing through partitions or walls does not require striker barriers.

c. Prohibited Locations:

1) Do not install piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
2) Do not install piping in return-air plenums.
3) Do not install piping in solid walls or partitions.

d. Under the Building: Install in vented containment conduit or CSST with integral vented sleeve and associated fittings.

5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise on Drawings.
6. Locate valves for easy access from a standing position. Do not locate valves within return air plenums.
7. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Comply with requirements in Sections specifying gas-fired appliances and equipment, and verify final appliance and equipment locations for roughing-in requirements.
11. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of three pipe diameters, but not less than **3 inches (75 mm)** long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

12. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors, and terminate with weatherproof vent cap.
13. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
14. Connect branch piping from top or side of horizontal piping.
15. Install unions in pipes **NPS 2 (DN 50)** and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
16. Do not use LPG piping as grounding electrode.
17. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve. Remove and replace startup strainer with new strainer prior to final acceptance tests.
18. Install pressure gauge [**downstream**][**upstream and downstream**] from each line regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."
19. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
20. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."
21. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.5 INSTALLATION OF SERVICE METERS

A. Install service-meter assemblies aboveground [**, on concrete bases**] .

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 INSTALLATION OF PRESSURE REGULATORS

A. Ensure the gas supply is completely shut off at the main valve and that the line is fully depressurized.

B. Remove any shipping plugs from the inlet, outlet, and vent connections. Ensure the pipe interior and regulator are free of dirt, debris, and contaminants.

C. Apply pipe joint sealant or Teflon tape rated for gas use to the male threads of the pipe. Avoid getting sealant on the female threads or inside the regulator.

D. Mount the regulator in the correct orientation, aligning the flow arrow on the body with the direction of gas flow. The piping must be properly aligned and supported to avoid stressing the regulator.

E. If the pressure regulator is installed inside of a building, install a dedicated vent line directly from the regulator to the outdoors. The vent terminal must be insect resistant and rain resistant. The regulator should be at least **3 ft. (914 mm)** horizontally from any building opening below the vent opening and positioned so that gas can disperse freely.

3.7 INSTALLATION OF GAS VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of CSST, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

F. Do not install valves in return-air plenums.

3.8 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for LPG service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.9 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for [**steel piping**][**and**][**copper tubing**] , with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and requirements of authorities having jurisdiction, whichever are most stringent.

D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and requirements

of authorities having jurisdiction, whichever are most stringent.

E. Support horizontal piping within [12 inches (300 mm)]<**Insert dimension**> of each fitting.

F. Support vertical runs of [**steel piping**][**and**][**copper tubing**] to comply with MSS SP-58, locally enforced codes, and requirements of authorities having jurisdiction, whichever are most stringent.

G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and requirements of authorities having jurisdiction, whichever are most stringent.

3.10 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install LPG piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas-shutoff valves and unions. Install valve within 72 inches (1830 mm) of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.

3.11 INSTALLATION OF TRANSPORT TRUCK UNLOADING FACILITY

A. Install transport truck unloading in a cast-in-place concrete base, 48 inches (1220 mm) square by 36 inches (914 mm) deep. Set top of concrete base at least 6 inches (150 mm) above finished grade.

B. Install remote emergency shutoff station with cable release in an accessible location, a minimum of 25 ft. (7.6 m) and a maximum of 100 ft. (30 m) away from transport truck unloading.

C. Install at least two 6-inch- (150-mm-) diameter metal bollards set in and filled with concrete on both sides of transport truck unloading. Bollard length is to be at least 48 inches (1220 mm) above and below grade, with concrete encasement a minimum of 12 inches (300 mm) in diameter.

3.12 INSTALLATION OF STORAGE CONTAINER

A. Do not install storage containers in a pit.

B. Fill storage container to at least 80 percent capacity with [**butane**][**propane**] .

C. Install piping connections with swing joints or flexible connectors to allow for storage container settlement and for thermal expansion and contraction.

D. Ground containers in accordance with NFPA 780. Grounding is specified in Section 264113 "Lightning Protection for Structures."

E. Set storage containers in felt pads on concrete or steel saddles. Install corrosion protection at container-to-felt contact.

F. Install tie-downs over storage containers on saddles with proper tension.

G. Set concrete saddles on dowels set in concrete base. Anchor steel saddles to concrete base.

H. Set storage container on concrete ballast base large enough to offset buoyancy of empty storage container immersed in water.

I. Install tie-down straps over container anchored in ballast base, and repair damaged coating.

J. Backfill with a minimum coverage for underground or mounded storage containers in accordance with NFPA 58.

K. Backfill with pea gravel as required in Section 312000 "Earth Moving."

L. Install cathodic protection for storage container. Cathodic protection is specified in Section 134713 "Cathodic Protection."

3.13 INSTALLATION OF VAPORIZER

A. Install vaporizer with access space for periodic maintenance.

B. Set vaporizers on and anchor to concrete base.

C. Connect liquid line from pump set, and connect vapor supply to distribution piping.

D. Install backup connection from vapor space of container to inlet of pressure-regulating valve at vaporizer discharge to bypass the vaporizer during maintenance. Install shutoff valves to change source from vaporizer to storage container.

3.14 INSTALLATION OF LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, **12 inches (305 mm)** below finished grade, except **6 inches (150 mm)** below subgrade under pavements and slabs.

C. Label and identify gas piping and pressure outside a multitenant building by tenant.

3.15 CONCRETE BASES

A. Anchor equipment to concrete base [.][**in accordance with seismic codes of Project. See Section 230548 "Vibration and Seismic Controls for HVAC."**]

B. Construct concrete bases of dimensions indicated, but not less than **4 inches (100 mm)** larger in both directions than supported unit.

C. Install dowel rods to connect concrete base to concrete floor. Install dowel rods on [**18-inch (451-mm)**]<**Insert dimension**> centers around the full perimeter of the base.

D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

F. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Use [**3000 psig (20.7 MPa)**]<**Insert value**> , 28-day, compressive-strength concrete and reinforcement, as specified in Section 033000 "Cast-in-Place Concrete."

3.16 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Comply with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction for testing, inspection, and purging of LPG installation.
2. LPG installation will be considered defective if it does not pass tests and inspections. Defective products are to be replaced. Retest installation after defective products have been replaced for code compliance.

B. Prepare test and inspection reports.

3.17 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain LPG equipment.

3.18 OUTDOOR LPG PIPING SCHEDULE

A. Underground LPG Piping: To be one of the following:

1. PE Pipe, Tubing, and Fittings: Terminate service-line risers with tracer wire in an accessible location.
2. Polyamide Pipe, Tubing, and Fittings: Terminate in an accessible location.
3. Steel Pipe: With wrought-steel welding fittings or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
4. Drawn-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
5. Annealed-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
6. Containment Conduit: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.
7. CSST and Fittings: With integral vented sleeve terminated in an accessible location.

B. Aboveground LPG Piping: To be one of the following:

1. CSST and fittings.
2. Steel Pipe: With [**malleable-iron threaded fittings**][**wrought-steel welded fittings or mechanical couplings**] .
3. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
4. Annealed-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

C. Branch Piping in Cast-in-Place Concrete to Single Appliance:

1. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints. Install piping embedded in concrete with no joints in concrete. Coat pipe and fittings with protective coating for copper tubing.

3.19 INDOOR LPG PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground Piping: To be one of the following:

1. CSST and Fittings.
2. Tin-Lined Copper Tube: With flared joints and fittings.
3. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints.
4. Aluminum Tube: With flared fittings and joints.
5. Steel Pipe: With [**malleable-iron threaded**][**wrought-steel welding**] fittings.
6. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

B. Underground (Below Building) Piping: To be one of the following:

1. Steel Pipe: With [**malleable-iron threaded**][**wrought-steel welding**] fittings.
2. Containment Conduit: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.
3. Containment Conduit Vent Piping: In accordance with [**NFPA 58,**][**the International Fuel Gas Code**] and requirements of authorities having jurisdiction.

3.20 INDOOR LPG PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: To be one of the following:

1. CSST and fittings.
2. Tin-Lined Copper Tube: With flared joints and fittings.
3. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints.
4. Aluminum Tubing and Piping: With flared fittings and joints.
5. Steel Pipe: With malleable-iron threaded fittings.
6. Schedule 40, steel pipe with steel welding fittings.
7. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

B. Underground (Below Building) Piping: To be one of the following:

1. Steel Pipe: With [**malleable-iron threaded**][**wrought-steel welding**] fittings.
2. Containment Conduit: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.
3. Containment Conduit Vent Piping: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.

3.21 INDOOR LPG PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: Maximum operating pressure more than [**5 psig (34.5 kPa)**]<**Insert pressure**> .

1. Steel Pipe: With wrought-steel welding fittings.

2. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

B. Underground (Below Building) Piping: To be the following:

1. Steel Pipe: With [**malleable-iron threaded**][**wrought-steel welding**] fittings.
2. Containment Conduit: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.
3. Containment Conduit Vent Piping: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.

3.22 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground Vapor Piping:

1. Manual gas shutoff ball valve - PE.
2. Manual gas shutoff valve - metallic.

3.23 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Aboveground LPG Piping: Manual gas shutoff valve - metallic.

END OF SECTION 33 52 16 13A

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Task	Specification	Specification Description
33 52 16 13	07 63 00 00	Common Work Results for Fire Suppression
33 52 16 13	22 05 00 00	Common Work Results for Plumbing
33 52 16 13	07 63 00 00a	Common Work Results for HVAC
33 52 16 23	33 52 16 13	Facility Natural-Gas Piping
33 52 16 23	33 52 16 13a	Facility Liquefied-Petroleum Gas Piping
33 52 16 26	33 52 16 13	Facility Natural-Gas Piping
33 52 16 26	33 52 16 13a	Facility Liquefied-Petroleum Gas Piping

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SECTION 33 71 00 00 - OVERHEAD MEDIUM-VOLTAGE WIRING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Conductors, connectors, and splices.
2. Wood poles.
3. Concrete poles.
4. Crossarms.
5. Guys and anchors.
6. Hardware and accessories.
7. Surge arresters.
8. Cutouts, switches, and fuses.
9. Pole-mounted distribution transformers.
10. Primary metering products.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.

1. Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).
2. Initial Unloaded Sag: The sag of a conductor before the application of an external load.

B. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 V or less.

C. Service: Set of insulated conductors extending from a pole to the metering point or service entrance connection at the location of utilization of electricity.

1.3 COORDINATION

A. Coordinate with utility supplying electricity to lines specified in this Section, and make [**final connections**][**arrangements for final connections by utility**].

B. Coordinate with those responsible for [**voice**][**data**][**video**]<**Insert services involved**> systems that will have cables supported by poles installed in accordance with this Section.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Conductors, connectors, and splices.
2. Wood poles.
3. Concrete poles.
4. Crossarms.
5. Guys and anchors.
6. Hardware and accessories.
7. Surge arresters.
8. Cutouts, switches, and fuses.
9. Pole-mounted distribution transformers.
10. Primary metering products.

B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory Test Reports:

a. Wood poles.
b. Concrete poles.
c. Crossarms.
d. Cutouts, switches, and fuses.
e. Pole-mounted distribution transformers.
f. Primary metering products.

2. Manufacturer's field reports for field quality-control support.

1.6 CLOSEOUT SUBMITTALS

A. Survey records for locations of pole, anchors, and other features for inclusion in Project Record Documents.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials**[, from same production run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Fuses: [**One**]<**Insert number**> additional spare fuse(s) or fuse element(s) for each furnished fuse or fuse element.
2. Padlocks: [**One**]<**Insert number**> for every [**three**]<**Insert number**> installed, but no fewer than [**three**]<**Insert number**>.
3. Insulators: [**One**]<**Insert number**> for every 10 of each type, but no fewer than [**three**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to overhead medium-voltage wiring, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. [**Two**]<**Insert number**> sets of special-purpose tools required for maintenance of cutouts, switches, and reclosers, complete with toolbox.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.

C. Comply with [**IEEE C2**][**CPUC General Order 95**], except where stricter requirements are indicated or where local requirements that are stricter apply.

D. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for [**heavy**][**medium**][**light**] line loading unless otherwise indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Wood Pole Storage and Handling: Comply with ATIS O5.1. Do not use pointed handling tools capable of producing indentations greater than **1 inch (25 mm)**.

PART 2 - PRODUCTS

2.1 CONDUCTORS, CONNECTORS, AND SPLICES

A. Conductor Type AAC: [**Bare**][**and covered**], all-aluminum, Alloy 1350-H19, complying with ASTM B230/B230M and ASTM B231/B231M.

B. Conductor Type AAAC: [**Bare**][**and covered**], all-aluminum-alloy, Alloy 6201-T81, complying with ASTM B398/B398M and ASTM B399/B399M.

C. Conductor Type ACSR: [**Bare**][**and covered**], aluminum conductor, steel reinforced, complying with ASTM B232/B232M.

D. Conductor Type CU: [**Bare**][**and covered**], hard-drawn copper, complying with ASTM B1 and ASTM B8.

E. Conductor Covering: UV resistant, complying with ICEA-S-70-547. [**HDPE**][**or**][**XLP**], [**150 mil (3.81 mm)**]<**Insert value**> thick.

F. Self-Supported, Multiconductor, Insulated Medium-Voltage Wiring: Factory-assembled, messenger-supported type, listed under UL 1072 as sunlight-resistant Type MV cable for cable tray use.

1. Conductors: [**Aluminum, Alloy 1350, complying with ASTM B230/B230M and ASTM**

B231/B231M][**Hard-drawn copper, complying with ASTM B1 and ASTM B8**]; stranded for 2 AWG and larger.

2. Conductor Insulation: [**XLP, complying with NEMA WC 70/ICEA S-95-658**][**EPR, complying with NEMA WC 70/ICEA S-95-658**]<**Insert insulation**>.
3. Insulation Level: [**100**][**133**]<**Insert number**> percent of rated circuit line-to-line voltage.
4. Conductor Shield: Extruded, nonconducting, thermoset material, complying with NEMA WC 70/ICEA S-95-658; **18 mil (460 µm)** minimum thickness.
5. Insulation Shield: Include the following two components:

    a. Nonmetallic conducting, material complying with NEMA WC 70/ICEA S-95-658 and UL 1072, extruded over, and free stripping from the insulation.
    b. Metallic Tape Shield: Bare copper, **5 mil (127 µm)** minimum thickness, helically applied with a 15 percent minimum overlap.

6. Conductor Jacket: Extruded, chlorosulfonated-polyethylene-based material, complying with NEMA WC 70/ICEA S-95-658.
7. Messenger: [**Copper**][**Composite copper and copper**]-clad steel.
8. Conductor Support Strap: Copper strap, wound around conductors and messenger the full length of the cable.

G. Aluminum Secondary-Voltage Line Conductors: [**Aluminum conductor, steel reinforced, complying with ASTM B232/B232M**][**Covered aluminum conductor, steel reinforced, complying with ICEA S-70-547, with HDPE or XLP covering**], [**60 mil (1.52 mm)**]<**Insert value**> thick.

H. Copper Secondary-Voltage Line Conductors: [**Bare hard-drawn copper, complying with ASTM B1 and ASTM B8**][**Covered hard-drawn copper, complying with ICEA S-70-547, with HDPE or XLP covering**], [**60 mil (1.52 mm)**]<**Insert value**> thick.[**Neutral-supported, secondary service-drop cable.**]

I. Racked Secondary Conductors, 600 V and Less: [**Copper, insulated with XLP, complying with NEMA WC 70/ICEA S-95-658**]<**Insert conductor and insulation combination**>.

J. Neutral-Supported, Secondary Service-Drop Cable, 600 V and Less: Insulated conductors with bare neutral, complying with ICEA S-76-474, and using the following combination of materials:

1. Conductors and Neutral: [**Copper with copper-clad-steel neutral**][**Aluminum with bare Alloy 1350 aluminum neutral**][**Aluminum with ACSR neutral**].
2. Insulation: [**XLP, complying with NEMA WC 70/ICEA S-95-658**][**High-modular-weight, low-density polyethylene**][**Weather-resistant polyolefin, complying with ICEA S-70-547**].

K. Connectors, Splices, and Conductor Securing and Protecting Components: Items include wire clamps, ties, conductor armor, fittings, connectors, and terminals. Listed for the specific applications and conductor types and combinations of materials used. Descriptions as follows for various applications:

1. Copper to Copper: Copper alloy, complying with UL 486A-486B.
2. Aluminum Composition to Aluminum Composition: Aluminum alloy, complying with UL 486A-486B.
3. Copper to Aluminum Composition: Type suitable for this purpose, complying with UL 486A-486B.
4. Connectors and Splices for Secondary Conductors: Listed and labeled for the conditions and materials involved in each application.
5. Taps for Medium-Voltage Line Conductors: Hot-line clamps, screw type, with concealed threads and bare, hard-drawn copper stirrups. Listed for the combination of materials being connected.
6. Splices under Tension: Compression type with strength exceeding the conductors spliced.
7. Splices and Terminations for Covered Conductors: As recommended by conductor manufacturer for conductor and covering combination and for specific materials and physical arrangement of

each splice.

8. Splices and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Section 260513 "Medium-Voltage Cables."

2.2 WOOD POLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ace Pole Company**]
2. [**Baxter, J. H. & Co**]
3. [**Bell Lumber and Pole Company**]
4. [**Brown Wood Preserving Co., Inc.**]
5. [**Dayton Superior Corporation**]
6. [**Koppers Performance Chemicals**]
7. [**McFarland Cascade**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ace Pole Company**]
2. [**Baxter, J. H. & Co**]
3. [**Bell Lumber and Pole Company**]
4. [**Brown Wood Preserving Co., Inc.**]
5. [**Dayton Superior Corporation**]
6. [**Koppers Performance Chemicals**]
7. [**McFarland Cascade**]
8. <**Insert manufacturer's name**>

C. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with [**creosote**][**pentachlorophenol,**][**ammoniacal copper arsenate,**][**ammoniacal copper zinc arsenate**][**chromated copper arsenate**].

D. Wood Species: [**Douglas fir**][**Lodgepole pine**][**Western larch**][**Southern yellow pine**]<**Insert wood species selected from ATIS O5.1**>.

E. Pole Marking:

1. Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft (3 m)** from the pole butt for poles **50 ft (15 m)** long or less.
2. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch (65 mm)** high, with aluminum nails.

F. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

2.3 CONCRETE POLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Accord Industries**]
2. [**Bayshore Concrete Products Corporation**]
3. [**CPI Concrete Products**]
4. [**StressCrete Group**]
5. [**Valmont Industries, Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Accord Industries**]
2. [**Bayshore Concrete Products Corporation**]
3. [**CPI Concrete Products**]
4. [**StressCrete Group**]
5. [**Valmont Industries, Inc.**]
6. <**Insert manufacturer's name**>

C. Description: Spuncast prestressed concrete, complying with requirements of ASTM C1089.

1. Comply with requirements of RUS Bulletin 1724E-216.

D. Design: Base design on calculation of strength required by IEEE C2 or indicated on Drawings, whichever is greater. Design must be suitable for installation at a location where annual temperature range is between [**minus 4 deg F and plus 100 deg F (minus 20 deg C and plus 38 deg C)**]<**Insert design temperature range at site location**>. Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.

E. Shaft: Hollow, for poles at overhead-to-underground connections. Provide metric designator 91 (trade size 3-1/2) minimum cable raceway capacity, with [**conduit elbow**][**cable entry port**] at base.

F. Water Absorption: Not more than 3 percent.

G. Surface: Smooth, hard, nonporous, and resistant to [**soil acids**][**road salts**][**frost and freezing damage**].

H. Pole Marking:

1. Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft (3 m)** from the pole butt for poles **50 ft (15 m)** long or less.
2. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch (65 mm)** high.

2.4 CROSSARMS

A. Description: [**Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade**][**Galvanized, steel angles**], and complying with IEEE C2 for required climbing space and wire clearances.

B. Braces: Galvanized, flat, ferrous-metal units; **1/4 inch (6 mm)** thick by **1-1/4 inch (30 mm)** wide, minimum, with length to suit crossarm dimensions.

2.5 GUYS AND ANCHORS

A. Guy Strand Assemblies: Cable and attachment assemblies must have uniform minimum breaking strength of the cable.

1. Cable: Seven strands. [**Zinc-coated steel, complying with ASTM A475**][**Aluminum-clad steel, complying with ASTM B416**][**Copper-clad steel, complying with ASTM B228**]. Breaking strength must be not less than [**10,000 lb (45 kN)**]<**Insert value**>.
2. Cable Termination:

a. Thimble eye.
b. Hooks and guy strain plates, complying with IEEE C135.1.
c. Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.

B. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.

1. Power-installed screw-type anchors.

a. **15 inch (380 mm)** screw; with rod **8 ft (2.4 m)** long by **1-1/2 inch (38 mm)** in diameter. Rated at **10,000 lb (45 kN)** when installed.
b. Guy anchors must have strength and holding area as required for anchor load and soil conditions at location of that anchor.

2. <**Insert anchor size or type**>.

C. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Installation of Guys and Anchors" Article.

D. Guy Markers: Round, of vinyl or PVC material, [**white**][**yellow**] color, **8 ft (2.4 m)** long. Shatter resistant at temperatures below **0 deg F (minus 18 deg C)**.

2.6 HARDWARE AND ACCESSORIES

A. Description: Ferrous-metal items include, but are not limited to, bolts, nuts, washers, crossarm gains and braces, insulator pins, anchor rods, anchors, eyebolts, staples, and transformer brackets.

1. Comply with IEEE C135.1, IEEE C135.2, ANSI C135.4, ANSI C135.22, and RUS Informational Publication 202-1 listings[**with the exception that base material must be malleable iron or ductile iron, and finish must be hot-dip galvanized**].

B. Insulator Brackets: Hot-dip galvanized steel, style as indicated, designed to hold vertical-post-type or pin-type insulators, with [**one**][**two**]-bolt attachment to pole.

C. Secondary Insulator Racks: Hot-dip galvanized steel, style as indicated, with smooth, rounded 12 gage struts designed to support [**two**][**three**][**four**] spool insulators for attachment of secondary drop conductors. Spool spacing of [**4 inch (100 mm)**][**8 inch (200 mm)**][**12 inch (300 mm)**].

D. Pole Riser Shields: Galvanized steel with [**boot**][**backplate**][**vent**].

E. Padlocks: ASTM F883.

1. Class: [**PO1**][**PO2**].
2. Grade: [**1**][**2**][**3**][**3**][**5**][**6**].

3. Option: [**A**][**B**][**C**][**D**][**E**][**F**][**G**].

F. Insulators: Units rated 6 kV and above must be free from radio interference.

1. Porcelain insulators must be wet-process type, complying with the following:

a. Pin: ANSI C29.5.
b. Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.
c. Suspension: ANSI C29.2.
d. Guy Strain: ANSI C29.4.
e. Secondary Spool: ANSI C29.3, Class 53-2.

2. Polymer-composite, fiberglass-reinforced insulators must comply with the following:

a. Line Post: CEA LWIWG-02.
b. Dead End/Suspension: CEA LWIWG-01.
c. Guy Strain: Fiberglass reinforced, epoxy finished. Designed specifically for use in guy assemblies.

G. Grounding Materials: Comply with Section 260526 "Grounding and Bonding for Electrical Systems," using materials listed by RUS for the intended purpose without restriction.

1. Conductors: 4 AWG, minimum; bare, solid, annealed copper, complying with ASTM B8 unless otherwise indicated.
2. Ground Conductor Protectors: PVC or half-round wood molding, [**fir, pressure treated in accordance with AWPA C25**][**cypress**][**cedar**].

2.7 SURGE ARRESTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Hubbell Utility Solutions; Hubbell Incorporated**]
5. [**MacLean Power Systems**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Hubbell Utility Solutions; Hubbell Incorporated**]
5. [**MacLean Power Systems**]
6. <**Insert manufacturer's name**>

C. Distribution-Class Surge Arresters: [**Porcelain**][**Polymer**]-enclosed, gapless, metal-oxide type[**with automatic-indicating type, ground-lead disconnection feature**], complying with IEEE C62.11 and NEMA LA 1.

D. Intermediate-Class Surge Arresters: [**Porcelain**][**Polymer**]-enclosed, gapless, metal-oxide type, complying with IEEE C62.11 and NEMA LA 1.

1. Voltage Rating: [**3**][**6**][**9**][**10**][**12**][**15**][**27**][**30**][**36**] kV[**, at the altitude of Project,**] unless otherwise indicated.

2.8 CUTOUTS, SWITCHES, AND FUSES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
3. [**Hubbell Utility Solutions; Hubbell Incorporated**]
4. [**Joslyn Hi-Voltage**]
5. [**MacLean Power Systems**]
6. [**S&C Electric Company**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
3. [**Hubbell Utility Solutions; Hubbell Incorporated**]
4. [**Joslyn Hi-Voltage**]
5. [**MacLean Power Systems**]
6. [**S&C Electric Company**]
7. <**Insert manufacturer's name**>

C. Description: Medium-voltage disconnect, protective[**, and bypass**] units must be rated for the line-to-line voltage of the systems in which installed, unless higher ratings are indicated. BIL ratings are [**45**][**60**][**75**][**95**][**150**][**200**] kV.

1. Momentary Current Rating of Switching Devices: [**20**][**40**]<**Insert value**> kA, asymmetrical at nominal system operating voltage.
2. Fuse Characteristics: Time-current characteristics for each set of fuses selected in accordance with published recommendations of manufacturer of component protected by the fuses and coordinated with upstream and downstream protective devices. Prepare time-current coordination curves in accordance with IEEE 242 that illustrate optimum coordination of devices in this Project.
3. Interrupting Rating of Fuses: <**Insert value**> symmetrical A at nominal system operating voltage.

D. Fuse Cutouts: [**Open**][**enclosed**] type, rated [**100**][**200**] A, continuous, complying with ANSI C37.42.

1. Fuses: Enclosed link, [**Type K**][**Type T**], complying with ANSI C37.42.
2. Fuse Current Rating: 150 percent of the transformer full-load current unless otherwise indicated.
3. Switching Application: Include switch link instead of fuse.
4. Switch Current Interrupting Rating: [**Transformer magnetizing current**]<**Insert value**>.

E. Fused Switches: Single-pole, manual units.

1. Switch Rating: [**400**][**600**] A(rms) continuous and load-current interrupting.
2. Fuses: Dropout-type power fuses.

F. Nonfused Switches: Single-pole, manual units, rated [**100**][**200**][**400**][**600**] A(rms) continuous.

G. Group-Operated, Load-Interrupter Switches: [**Fused**][**Nonfused**], three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.

1. High-pressure contact type, complying with ANSI C37.32.
2. Factory assembled to suit specific configuration and mounting conditions for this Project.
3. Operating Handle: Padlock equipped.
4. Current Interrupting Rating: Equal to continuous current rating of switch.
5. Fuses: Nondropout power type.

H. Group-Operated, Air-Break (Nonloadbreak) Switches: Three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.

1. Comply with ANSI C37.32.
2. Factory assembled to suit specific configuration and mounting conditions for this Project.
3. Operating Handle: Padlock equipped.
4. Suitable for field conversion to load-interrupter switch by adding interrupter modules.

2.9 POLE-MOUNTED DISTRIBUTION TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Howard Industries, Inc**]
5. [**Kuhlman Electric Corporation**]
6. [**Pauwels Transformers**]
7. [**Pioneer Transformers Ltd**]
8. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Howard Industries, Inc**]
5. [**Kuhlman Electric Corporation**]
6. [**Pauwels Transformers**]
7. [**Pioneer Transformers Ltd**]
8. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
9. <**Insert manufacturer's name**>

C. Description: Single-phase, two-winding, [**single**][**two**]-bushing, liquid-filled, self-cooled, pole-mounting distribution type, suitable for external fuse and surge suppressor protection; complying with IEEE C 57.12.00, and tested in accordance with IEEE C 57.12.90[**.**][**and with the following additional requirements:**]

1. Cooling Class: OA.

2. Temperature Rise: 65 deg C.
3. Insulating Liquid:

    a. Mineral oil, ASTM D3487, Type II.
    b. High molecular weight, mineral oil based, and UL listed as less-flammable type.
    c. Biodegradable insulating and cooling liquid, UL listed as less flammable type.
    d. Identification: Label the transformer as "non-PCB" and place manufacturer's name and type of fluid on the nameplate.

D. BIL: [**95**][**75**][**60**] kV.

E. Primary Voltage: <**Insert voltage**>.

F. Taps: [**Two, 2.5 percent above and below**][**Four, 2.5 percent below**], high-voltage and full-load rated.[**Tap changer must have an external operating handle.**]

G. Mounting Brackets: [**Single**][**Double**], integral; suitable for pole mounting, individually or in cluster, or on crossarm.

H. Minimum Efficiency: Class 1, as defined by NEMA TP 1, based on test results that comply with requirements of NEMA TP 2.

I. Bushings: Creepage distance must exceed nominal value standard for unit rating by at least 75 percent.

J. Hardware: Stainless steel.

K. Tank and Cover: Stainless steel, complying with ASTM A167, Type 304 or 304L, with paint coating exterior finish system complying with IEEE C57.12.28, including manufacturer's standard color finish coat.

L. Show transformer kiloampere capacity using **2-1/2 inch (65 mm)** numerals placed near the low-voltage bushings.

2.10 PRIMARY METERING PRODUCTS

A. Primary Metering Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**GE Power; General Electric Company**]
    c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
    d. [**Landis+Gyr Inc.**]
    e. [**Schweitzer Engineering Laboratories, Inc.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]

b. [**GE Power; General Electric Company**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Landis+Gyr Inc.**]
e. [**Schweitzer Engineering Laboratories, Inc.**]
f. <**Insert manufacturer's name**>

B. Metering Transformers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Power; General Electric Company**]
b. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
c. [**Kuhlman Electric Corporation**]
d. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**GE Power; General Electric Company**]
b. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
c. [**Kuhlman Electric Corporation**]
d. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
e. <**Insert manufacturer's name**>

C. Description: Outdoor current and potential transformers, designed for crossarm mounting, complying with IEEE C57.13, and having the following features:

1. BIL: [**45**][**60**][**75**][**95**][**150**][**200**] kV.
2. Secondary connection box arranged for conduit connection.
3. Potential-Transformer Voltage Rating: [**2.4**][**4.16**][**7.2**][**12.0**][**12.47**]<**Insert value**> kV to 120 V(ac), 60 Hz.
4. Potential-Transformer Accuracy Class: Minimum 0.3 at [**75**]<**Insert value**> VA burden.
5. Voltage Rating: [**2.4**][**4.16**][**7.2**][**12.0**][**12.47**]<**Insert value**> kV.
6. Current Rating: <**Insert value**> to 5 A.
7. Accuracy Class: Minimum 0.2 at [**50**]<**Insert value**> VA burden.

D. Watt-Hour Meter: Outdoor solid-state unit, [**with demand register,**][**arranged for pulse initiation,**] complying with ANSI C12.10, and including the following ratings and features:

1. Form: [**8S**][**9S**].
2. Element: [**2**][**2-1/2**][**3**].
3. Voltage: 120 V.
4. Current: 2-1/2 A.
5. Frequency: 60 Hz.
6. Kilowatt-Hour Register: Five-digit type.
7. Demand-Register Multiplier: A quantity in even hundreds, indicated on meter face.
8. Demand-Register Interval: [**15**][**30**] minutes.
9. Mounting: On matching socket, complying with ANSI C12.7, and complete with automatic current short-circuiting device.
10. Meter Test Block: Matched to meter, and furnished and equipped with open knife switches

designed to isolate each metering component for test.

11. Meter Cabinet: Galvanized steel; weatherproof enclosure with pole-mounting bracket and the following features:

    a. Hinged Door: Arranged for padlocking in closed position.
    b. Size: Adequate to house meter and other equipment indicated, but not less than **20-by-30-by-11 inch (510-by-760-by-280 mm)** deep.

2.11 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. For each type of product include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Material Certificates: For the following items, from manufacturers:

    a. Wood poles.
    b. Concrete poles.
    c. Wood crossarms.

3. Listing Documentation: Indicate that products comply with requirements specified in "Quality Assurance" Article.
4. Time-Current Coordination Curves: Illustrate optimum coordination of protective devices involved in the Work of this Section.

B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. Factory Tests:

1. Testing Administrant: [**Owner will engage**][**Engage**] qualified pole and crossarm inspection agency to evaluate poles and crossarms.
2. Factory Tests and Inspections:

    a. Inspect poles and crossarms, by, or under supervision of, qualified pole and crossarm inspection agency recognized by authorities having jurisdiction, in accordance with referenced standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified pole and crossarm inspection agency's**] certification of system compliance.

        1) RUS quality mark "WQC" on each item is acceptable in place of inspection as evidence of compliance.

    b. Conduct routine tests of [**transformers**][**medium-voltage switches**][**and**][**metering equipment**] by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with referenced standards. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

3. Nonconforming Work: Units that do not pass tests and inspections will be considered defective.
4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 RIGHT-OF-WAY CLEARANCE AND TREE TRIMMING

A. Clear right of way in accordance with Section 015639 "Temporary Tree and Plant Protection" and Section 311000 "Site Clearing."

B. Clear right of way to maintain minimum clearances required by IEEE C2, unless Drawings indicate greater clearances or greater clearances are required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of **15 ft (4.5 m)** on both sides horizontally and below medium-voltage conductors and **60 inch (1500 mm)** on both sides horizontally and below secondary-voltage conductors. Remove overhanging branches.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install underground power and metering circuits and those circuits indicated to be in raceways in accordance with Section 260543 "Underground Ducts and Raceways for Electrical Systems" and Section 260513 "Medium-Voltage Cables," and make splices and terminations for those circuits in accordance with the applicable Sections.

B. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document must also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Apply warning signs and equipment labels in accordance with Section 260553 "Identification for Electrical Systems."

3.3 INSTALLATION OF MEDIUM-VOLTAGE LINE CONDUCTORS

A. Selection: Install bare conductors unless otherwise indicated.

B. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening, or deformation. Remove damaged sections and splice conductors.

1. String new conductors to "initial" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
2. Conductors Reinstalled or Resagged: String to "final" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.

C. Connections, Splices, and Terminations: Use kits listed for the specific type of connection and combination of materials in the connection or recommended for the specific use by manufacturer of material on which applied.

1. Splice Location: Do not install within **10 ft (3 m)** of a support.
2. Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.
3. Splices and Terminations of Covered Conductors: Comply with manufacturer's published

instructions.

4. Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's published instructions.

D. Armor Rod: Install to protect conductors if line conductors are supported by insulators.

E. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.

F. Support line conductors and taps as follows:

1. Use wire ties for conductor attachment to pin and vertical post insulators unless otherwise indicated.
2. Install wire ties tight against conductor and insulator, and turn ends back and flat against conductor, to eliminate exposed wire ends.
3. Use wire clamps on horizontal post, dead end, and suspension insulators unless otherwise indicated.

3.4 INSTALLATION OF POLES AND CROSSARMS

A. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.

B. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and in accordance with the following:

1. On level ground, set poles so tops of consecutive poles vary not more than **60 inch (1500 mm)** in elevation.
2. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.

C. Set poles in accordance with the following:

1. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
2. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:

    a. Poles up to 35 ft (10.6 m) Long: **24 inch (600 mm)**.
    b. Poles 36 to 60 ft (11 to 18.3 m) Long: **30 inch (760 mm)**.
    c. Poles 61 to 75 ft (18.6 to 22.9 m) Long: **36 inch (900 mm)**.

3. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
4. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain **1 inch (25 mm)** minimum, **2 inch (51 mm)** maximum, (after conductors are installed at required tension) for each **10 ft (3 m)** of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
5. Backfill holes in **6 inch (150 mm)** maximum lifts, and thoroughly tamp each layer before starting the next.
6. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
7. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead

ends; place gains on last two poles on side facing terminal or dead end.

8. Poles Set in Concrete Paved Areas: Install poles with minimum of **6 inch (150 mm)** wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with [**pea gravel**]<**Insert appropriate material**> to a level **1 inch (25 mm)** below top of concrete slab.

D. Field treat factory-treated poles and crossarms as follows:

1. Poles Treated More Than One Year before Installation: Treat portion from **24 inch (600 mm)** above ground line to butt.
2. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
3. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
4. Engage the services of qualified wood pole and crossarm treatment technician to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.

E. Crossarm Installation: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

1. Buck Arms: Install at corners and junction poles unless otherwise indicated.
2. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
3. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
4. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

F. Locate pole numbers to provide maximum visibility from the road or patrol route.

3.5 INSTALLATION OF GUYS AND ANCHORS

A. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inch (900 mm)** or more. Comply with IEEE C2.

1. Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
2. At the anchor end, attach guy strand assembly with preformed grips.

B. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.

C. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio must be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.

D. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inch (150 to 230 mm)** from ground.

E. Install strain insulators to provide a minimum of **12 inch (300 mm)** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators must be loaded to not more than two-thirds of manufacturer's published rating.

F. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

3.6 INSTALLATION OF HARDWARE AND ACCESSORIES

A. Install washers against wood and under nuts, including eyenuts and locknuts.

B. Install nuts and locknuts wrench-tight on threaded connections.

C. Medium-Voltage Line Insulators: Install [**pin**][**or**][**post**] type, except install suspension type at corners, angles, dead ends, and other locations where horizontal forces exceed rated values for pin or line-post-type units.

1. Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.
2. Install horizontal line-post insulators for armless construction.

D. Post-Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.

E. Install spool-type insulators for secondary lines mounted on clevis attachments or secondary racks.

F. Guy Strain Type Insulators: Install [**porcelain**][**fiberglass-reinforced**] units.

3.7 INSTALLATION OF SURGE ARRESTERS

A. Install surge arresters to protect [**distribution**][**metering equipment**][**reclosers**], [**group-operated, load-interrupter switches**], [**aerial-to-underground transitions**], and other items indicated.

1. Units Installed 6000 ft (1800 m) or More above Sea Level: Use arresters specifically rated for this service.

3.8 INSTALLATION OF CUTOUTS, SWITCHES, AND FUSES

A. Hook-Stick-Operated Switches: Install to maximize safe operating access.

B. Group-Operated, Load-Interrupter Switches and Air-Break Switches: Install operating handle **42 inch (1067 mm)** above finished grade.

1. Locking Provisions: Install padlock at hasp.

3.9 INSTALLATION OF PRIMARY METERING PRODUCTS

A. Current and Voltage Transformers: Install secondary conductors between transformers and cabinet in sleeves made of [**galvanized rigid steel**][**intermediate metal**][**PVC**] conduit. Install to prevent collection of moisture in raceway and cabinet system.

B. Meter Cabinet: Mount on pole, **72 inch (1825 mm)** above finished grade to center of cabinet.

1. Make conduit connections with raintight hubs.
2. Install metering transformer secondary leads without splices. Train leads at sides and bottom of enclosure, and secure with wire ties.
3. Install meter and meter test block within cabinet.
4. Install identical phase sequence, and color-code for both potential and current leads.
5. Identify leads using designations consistent with marking on transformer terminals.

3.10 GROUNDING

A. Comply with IEEE C2 grounding requirements.

B. Ground Rods: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch-by-10 ft (19 mm-by-3 m)**][**5/8 inch-by-8 ft (16 mm-by-2.4 m)**] in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install [**two**]<**Insert number**> parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 Ω.
2. Drive ground rods until tops are **12 inch (300 mm)** below finished grade in undisturbed earth.

C. Grounding Conductors:

1. 4 AWG minimum, soft-drawn copper.
2. Conductor Protectors for Wood Poles: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communications service and transformer spaces.
3. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
4. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
5. Transformer Enclosures and Secondary Neutrals: Interconnect and connect to grounding conductor.

3.11 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Furnish instruments and equipment required for tests that comply with NETA Acceptance Testing Specification.
2. Guy Anchors: Test one of each type and capacity installed[**, plus additional units specifically indicated for testing**]. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

    a. Acceptable Test Results: Denoted by movement of less than **3/8 inch (10 mm)** by the holding component of the anchor in the earth or other medium in which it is installed.
    b. Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.

3. Ground Resistance: Comply with Section 260526 "Grounding and Bonding for Electrical Systems." Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.

    a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
    b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground,

tested individually, exceeds 25 Ω, add a ground electrode not less than **10 ft (3 m)** away and interconnect with 2 AWG, minimum, bare conductor buried at least **12 inch (300 mm)** below furnished grade.

4. Aerial Conductor Sag and Tension: Observe procedures used by Contractor to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's product data and published recommendations.
5. Self-Supported, Medium-Voltage Cable: After installation, while cable is isolated, and after terminations are installed and before connecting or energizing, apply DC voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with NEMA WC 70/ICEA S-95-658 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.
6. Neutral-Supported, Secondary Service-Drop Cable: Test for insulation resistance while cable is isolated, before connecting or energizing. Minimum acceptable resistance is 100 MΩ.
7. Existing Surge Arresters: Disconnect and measure resistance between line and ground terminals with a megger test rated 600 V or more. Acceptable resistance values are 300 MΩ and more.
8. New Surge Arresters, Cutouts, and Switches: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.

    a. Verify proper grounding of metallic equipment parts.
    b. Fuses and Disconnect Links: Verify that ratings and characteristics match submittals and comply with system requirements.
    c. Switches:

        1) Manually operate each cutout and switch at least three times, to verify proper operation.
        2) Verify correct contact alignment, blade penetration, travel stops, and arc interrupter operation.

    d. Group-Operated, Load-Interrupter Switches and Air-Break Switches:

        1) Perform mechanical operator tests in accordance with manufacturer's published instructions.
        2) Test resistance to ground of parts to be energized. Acceptable value is 200 000 MΩ.
        3) Perform contact-resistance test across all switch blade contacts. Refer to manufacturer's data for acceptable contact resistance.

    e. Verify that clearances of energized parts and connecting wires comply with IEEE C2 requirements.

9. Distribution Transformers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

    a. Inspect for physical damage, cracked insulators, leaks, tightness of connections, and overall mechanical and electrical integrity.
    b. Perform preenergizing inspections and tests recommended by manufacturer.
    c. Verify proper equipment grounding.
    d. Verify that clearances of terminals and connecting wires comply with IEEE C2.

10. Metering Transformers: Inspect after installation and connection to wires, and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

a. Verify proper connections, tightness of bolted connections, and integrity of mounting provisions.
b. Verify that required grounding and shorting connections provide good contact.
c. Verify that clearances of terminals and connecting wires comply with IEEE C2.
d. Perform electrical tests in accordance with manufacturer's published instructions, including insulation-resistance tests, polarity tests, and turns-ratio and ratio-verification tests.

11. Meters: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

a. Verify tightness of electrical connections.
b. Verify accuracy at 25, 50, 75, and 100 percent of full-rated load and verify all instrument multipliers in accordance with manufacturer's published instructions.

D. Nonconforming Work:

1. Units will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.12 ADJUSTING

A. Pole-Mounted Distribution Transformers: Set voltage taps as directed by Architect.

3.13 CLEANING

A. After completing equipment installation, inspect equipment. Remove spots, dirt, and debris. Repair damaged finish to match original finish. For distribution transformer, use tank touchup paint provided by manufacturer.

1. Clean enclosures internally, on completion of installation, in accordance with manufacturer's published instructions.

END OF SECTION 33 71 00 00

Task	Specification	Specification Description
33 71 19 00	33 71 00 00	Overhead Medium-Voltage Wiring
33 71 19 13	33 71 00 00	Overhead Medium-Voltage Wiring
33 71 19 23	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
33 71 19 23	26 05 43 00a	Underground Ducts and Utility Structures
33 71 19 23	26 05 19 16	Communications Equipment Room Fittings
33 71 19 23	26 05 19 16a	Communications Copper Backbone Cabling
33 71 19 23	26 05 19 16b	Communications Coaxial Horizontal Cabling
33 71 19 23	33 71 00 00	Overhead Medium-Voltage Wiring

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SECTION 34 01 23 33 - RAIL TRACKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of railroad track and accessories. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit the following.
1. Shop Drawings
   a. Turnouts
   b. Road crossings
   c. Car bumper
   d. Railroad crossings
   e. Layout drawings
2. Product Data
   a. Rails
   b. Wood ties
   c. Precast concrete ties
   d. Tie plates
   e. Tie pads
   f. Track bolts, nuts, and spring washers
   g. Standard, compromise, and insulated joint bars
   h. Rail anchors
   i. Rail clips and fasteners
   j. Track spikes
   k. Turnouts
   l. Pre-manufactured road crossings crossing surfaces
   m. Car bumper
   n. Wheel stops
   o. Derails
   p. Gage rods
   q. Switch point protectors
   r. Switch stands
   s. Geotextile fabric
3. Test Reports
   a. Ties preservative treatment
   b. Ballast tests
4. Certificates
   a. Rail welding procedures
5. Operation and Maintenance Data
   a. Rails
   b. Accessories
   c. Pre-manufactured road crossings
   d. Turnouts

C. Temporary Work: During construction, provide suitable roads and crossing with necessary lights, signs, drainage, and other appurtenances required for safe public and local travel. Erect and maintain suitable temporary fences where required to prevent trespass upon work or damage to adjoining property. Maintain drainage and prevent accumulation of water that might affect roadbed stability.

D. Quality Assurance

1. Layout Drawings: Layout Drawings: Submit for approval by the Owner before work is started. Do not prepare layout drawings until field surveys and measurements are completed. Do not order materials until layout drawings are approved. Include on layout drawings locations of turnouts, various sizes of rail, compromise joints, and locations of rail accessories.
2. Ties Preservative Treatment: Ties shall be marked in accordance with American Wood-Preservers' Association (AWPA) M6 and inspected in accordance with AWPA M2, for conformance with the specified AWPA Standards, by an independent inspection agency approved by the Owner. The agency's report of inspection shall accompany delivery of the ties, and shall be provided to the Owner's representative.

1.2 PRODUCTS

A. Ballast, Subballast and Geotextile
1. Ballast: Crushed stone Size No. 3, 4, 4A, 5, or 57 conforming to American Railway Engineering and Maintenance-of-Way Association (AREMA) Ch. 1 for quality, soundness and gradation. Ballast materials shall meet the property requirements shown in Table I.

TABLE I - MINIMUM PROPERTY REQUIREMENTS - BALLAST

Property	Test Method	Max. Value	Min. Value
Percent Passing (No. 200) Sieve	ASTM C 136	1.0 percent	
Bulk Specific Gravity - Rock	ASTM C 127		2.60
Absorption - Rock	ASTM C 127		2.0 percent
Clay Lumps and Friable Particles	ASTM C 142	0.5 percent	
Degradation	ASTM C 131 ASTM C 535	35 percent	
Soundness	ASTM C 88		
Sodium Sulfate - 5 Cycles		10 percent	

2. Subballast: Consists of aggregate-soil mixtures conforming to an ASTM D 1241 Type I, Gradation A **OR** B, **OR** C, **OR** D, **as directed,** mixture as approved.
3. Geotextile Fabric: Consists of a needle-punched nonwoven material that provides a permeable layer, planar flow, and tensile reinforcement, while retaining the soil matrix. Fabric shall be inert to commonly encountered chemicals, mildew, rot, insects, rodents and shall be treated to resist degradation caused by exposure to sunlight. Fabric will conform to the properties in Table II.

TABLE II - MINIMUM PROPERTY REQUIREMENTS - GEOTEXTILE FABRIC

Fabric Property	Test Method	Fabric Requirement Minimum Value
Grab Tensile Strength, (lbs)	ASTM D 4632	175
Grab Tensile Elongation, percent	ASTM D 4632	20
Coefficient of Water Permeability, (cm/sec)	ASTM D 4491	0.10
Puncture Strength, (lbs)	ASTM D 3787*	110
Mullen Burst Strength, (psi)	ASTM D 3786	400
Apparent Opening Size (AOS) (U.S. Standard Sieve)	COE CW 02215	70

*Tension testing machine with ring clamp; steel ball replaced with a 5/16-inch diameter solid steel cylinder, with flat tip and beveled edges, centered within the ring clamp.

B. Rails: New, minimum 115 pound RE section conforming to AREMA Ch. 4. Provide in 39 **OR** 78, **as directed**, foot lengths. Provide no closure pieces less than 13 feet. Bend in shop curved rail to proper radii, where degree of curvature exceeds 18 degrees.

1. Relayer Rail: Ninety pounds or heavier up to 136 pounds. Characteristics shall conform to requirements of MIL-R-3911 as modified in Table III:

TABLE III - RELAY RAIL CHARACTERISTICS

Minimum Weight per Yard	(original (lbs):	(90 to 136)
Wear:	Max. top wear (in.):	(3/16)
	Max. side wear (in.):	(1/8)
Length:	As ordered but not less than (13 feet).	
Defects permitted:	None	
Max. Lip (in.):	(1/16)	

2. Relayer rail shall be of the same section and drilling pattern throughout the project, except that the drilling pattern for bolt holes at turnouts shall be as indicated. No mingling of new and relayer rail will be permitted, and all relayer rail of the same section and drilling pattern shall be kept together in one area.

C. Wood Ties: Except as otherwise noted, ties shall be in accordance with FS MM-T-371, Types II cross ties and III switch ties, treated in accordance with AWPA C6. Species shall be as listed in FS MM-T-371 except that species shall not be mixed in a charge or bundle. Each treated piece shall be permanently marked or branded, by the producer, in accordance with AWPA M6. All ties except Southern, red, and ponderosa pine shall be incised prior to treatment. Splits shall not be longer than 4 inches nor wider than 1/4 inch at either end. Splits longer than 4 inches but not longer than the width of the face in which the split appears shall be acceptable if anti-splitting devices are installed with splits compressed. S-irons, dowels, and end plates are acceptable anti-splitting devices. Treatment shall be verified by an approved independent inspection agency report. Note: When the Owner inspections result in product rejection, the Contractor shall promptly segregate and remove rejected material from the premises. the Owner may also charge the Contractor additional cost of inspection or test when prior rejection makes reinspection or retest necessary.

1. Cross Ties: Size: 7 inches thick by 9 inches wide. Length: 8 feet 6 inches.
2. Switch Ties: Size: 7 inches thick by 9 inches wide. Length and quantities as indicated.
3. Tie Plugs: Conform to AREMA Ch. 30. Treat plugs with creosote-coal-tar solution of 8 pounds per cubic foot in accordance with AWPA C6. Provide plugs to fit holes from which spikes are drawn.

D. Precast Concrete Ties: Provide in the dimensions indicated, designed and manufactured in accordance with AREMA Ch. 8. Provided by manufacturers regularly engaged in the manufacture of precast concrete ties and essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening.

1. Tie Plates: Provide new or used tie plates in good condition conforming to AREMA Ch. 5-1. Provide plates of the dimensions and punching pattern to fit the rail. Relayer (used) tied plates provided shall have no deformities or cracks, a minimum amount of surface rust, no pitting in excess of 1/16 inch deep, no cutters (bottom ribs), 1:40 cant on rail seat area, a maximum of 1/8 inch wear on seat section and physical dimensions in accordance with AREMA Ch. 5-1. The relayer tie plates may be repunched to accept base of existing rails but no slotting shall be accepted. New holes must have one inch clearance from closest existing hole and no hole shall be punched on the shoulder side of tie plate. Relayer tie plates shall be approved on individual basis by the Owner.

E. Tie Pads: Conform to AREMA Ch. 30-2 for use with precast concrete ties.

F. Track Bolts, Nuts, And Spring Washers: Provide new throughout the project. Provide oval-neck, heat-treated, carbon-steel track nuts and carbon-steel track bolts conforming to AREMA 4-2. Spring washers shall conform to AREMA 4-2 and shall be of the size to fit the bolt and nut used and a minimum of 1/2 inch thick.

G. Joint Bars: Provide new or used joint bars in good condition conforming to AREMA Ch.4-3. For new construction, provide bars of the "toeless" head free type, of the size, shape, and punching pattern to fit the rail. Joint bars shall be 24 inches **OR** 36 inches, **as directed**, long and have four **OR** six, **as directed**, bolt holes. For repair work, provide head-contact joint bars. Contractor shall verify the punching pattern of existing rail before ordering joint bars.

H. Compromise Joint Bars: Provide new, conforming to AREMA Ch.4-3, for changes in rail size or where rail drilling differs. Compromise joints shall be angle bar type of forged or cast steel accurately machined to properly align the combination of rail sections indicated. Steel shall have physical properties equal to or exceeding AREMA specifications for those of standard rolled steel joints. Joints shall be manufactured by an established track appliance manufacturer.

I. Track Spikes: AREMA Ch. 5-2 for track spikes, size 6 by 5/8 **OR** 5 1/2 by 9/16, **as directed**, inches. Provide new spikes throughout the project.

J. Rail Clips And Fasteners: Provide single tight fit clips with fillers as necessary to fit rail section furnished. Clip or fastener design shall anchor rail against longitudinal movement.

K. Accessories
1. Rail Anchors: Standard manufacture as approved and of the size to fit the rail section. Where special installation tools are required, furnish a minimum of one tool for each 2,000 anchors.
2. Gage Rods: Provide Type A gage rods of 1 1/4 inch round steel rods with double adjustable clamps at both ends, suitably sized for use with the standard rail section furnished. Provide Type B gage rods of 1 1/4 inch round steel rods with a hook at one end and a single adjustable clamp at the other end, suitably sized for use with the standard rail section furnished. Use the product of a manufacturer who is regularly engaged in the manufacture of steel gage rods.
3. Switch Point Guard-Rail Type Protectors: Guard-rail type, standard manufacturer's product of heat-treated rail **OR** manganese steel, **as directed**, and of size to fit rail section furnished. Protectors shall be bolted to rails.
4. Flangeway Guard: Flangeway guard assembly shall include steel casting blocks, hook bolts, set bolts, and steel angle. The steel casting blocks and hook bolts shall be sized and provided to fit the rail section furnished and shall be a standard manufacturer's product, designed and constructed for use as a flangeway guard in railroad applications in pavement. Provide and secure steel angles to the steel casting blocks by the set bolts as indicated; other steel shapes shall not be substituted for steel angles shown. Prior to paving, the flangeway guard shall be coated with two coats of an asphalt varnish applied to a dry-film thickness of at least two mils total thickness.

5. Wheel Stops: Cast steel of double wedge design, and of standard commercial manufacture for the purpose.
6. Derails: Conform to MIL-D-11302 and satisfactory for use with the weight rail specified. Provide derails at locations and in numbers indicated or specified. Complete unit shall weigh not less than 100 pounds.
7. Car Bumper Post: Standard product of a commercial manufacturer of railroad accessories. Post shall be made from structural steel sections arranged for attachments to the rails by bolting, and located so that the thrust will be transmitted through the cross ties to ballast and earth. Post shall consist of a head to accept horizontal thrust of the car couple and transmit it to tension members and compression members having at least a moment of inertia not less than 17.1. Complete unit shall weigh not less than 800 pounds.

L. Oil: Oil for rail and other track materials, except joints, shall conform to the following:
1. Flash point: minimum 130 degrees F, ASTM D 1310.
2. Asphalt: 100 penetration, minimum 45 percent.
3. Viscosity: Saybolt Universal, 130 degrees F, 240 to 350 seconds, ASTM D 88.

M. Electrodes: Provide AWS low-hydrogen, high-tensile 140-16 (extrapolation) or 25-20 electrode, Grade 310-16 and 310-15 stainless steel rod welding electrodes. Provide electrodes of the smallest practical diameter worked at the lowest compatible current. Coating on low-hydrogen type electrodes shall be thoroughly dry when the electrode is provided. Use electrodes taken from hermetically sealed packages within one hour of the time the package is opened. Electrodes not used within this one-hour period and electrodes taken from non-hermetically sealed packages shall be dried for at least one hour between 700 and 800 degrees F. Electrodes so dried may be stored at temperatures between 225 and 400 degrees F until used, or, if not stored and not used within one hour after this drying is completed, shall be re-dried before use. Do not use electrodes which have been wet.

N. Turnouts: Component parts of the turnouts to be furnished shall be the products of manufacturers regularly engaged in the manufacture of such products, and shall essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening. The parts need not all be made by the same manufacturer, but each turnout shall be the product of a single firm. Provide complete, including all track materials and switch ties in accordance with appropriate area trackwork plan. Switch assemblies, stands, rigid bolted frogs, and guard-rail assemblies shall conform to AREMA PTWP (Portfolio of Trackwork Plans). One switch point in each turnout shall be manganese tipped in accordance with AREMA PTWP Plan governing manganese tipped switch points, installed on the side opposite the turnout side of the switch. Rail used in turnout shall be new end hardened, minimum 115 pound RE section, drilled for four **OR** six, **as directed**, holes. Bend in stock rail shall be in accordance with AREMA.
1. Turn Out Plates: Provide plates and rail braces in strict accordance with the current AREMA trackwork plan governing the turnout with respect to the number of the turnout. Provide turnout plate system complete with slide plates, heel plates, guard rail tie plates, hook twin tie plates, including those for the frog, rail braces, standard tie plates or other accessories required to complete the installation. Hook twin tie plates shall be in accordance with AREMA PTWP governing hook twin tie plates. Gage plates shall be solid. Rail braces shall be either fixed or adjustable type of standard manufacture.
2. Switch Stands: Low-stand type, adjustable from top with shims through a moveable cover and a replaceable double crank of malleable iron, complete with reflectorized red and white aluminum target minimum thickness 14 gage, self-locking connecting rod, reversible target tip arm crank, parallel throwing latch and interchangeable parts. Each stand shall be equipped with one of the following switch lamps as indicated:
    a. Reflecting type: Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses but without day signal targets.
    b. Reflecting type with daylight disk: Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses, and with approved day signal targets.

c. Illuminated type: Approved illuminated lamps with primary battery, battery housing, and cable.

O. Road Crossings
1. Bituminous, Wood or Treated Timber Crossings: Wood and treated timber material for road crossing shall conform to AWPA C6. Bituminous crossings shall conform to Division 2 Section "Hot-Mix Asphalt Paving."
2. Rubber Railroad Crossings: Manufacturers standard product for a rubber railroad crossing consisting of manufactured panels of full depth rubber or partial depth panels of rubber and steel conforming to the following requirements:
   a. Partial depth panels shall be reinforced with steel plates, arches, or post tensioned cable fully encased in the rubber. Post tensioned cables shall be encased with a polycarbon material before rubber encasement.
   b. Rubber hardness of 55 to 80 (tested in accordance with ASTM D 2240, Durometer A).
   c. Rubber tensile strength of 1000 psi to 2500 psi (tested in accordance with ASTM D 412).
   d. Rubber elongation of 100 to 400 percent (tested in accordance with ASTM D 412).
   e. Headers shall be manufacturer's standard rubber header.
   f. Shims shall be hardwood, treated with creosote in accordance with AREMA Ch 3, for lumber and timber in ground contact.
   g. Materials for securing the crossing shall be as recommended by the rubber crossing manufacturer.
   h. Provide components pertinent to each manufacturer's system to provide each rubber railroad system complete and ready for use.

1.3 EXECUTION

A. General Trackwork: Perform track construction not covered specifically herein in accordance with AREMA MRE (Manual for Railway Engineering (Fixed Properties) recommended practices.

B. Subgrade Preparation: Obtain approval of roadbed surface, grade, and drainage prior to distribution of construction material. Provide equipment that will not form ruts or water pockets when distributing material over the finished road bed. Where subgrade or road bed surface is damaged, perform repairs including regrading and recompaction in accordance with Division 2 Section "Earthwork."

C. Ties
1. Wood Ties: Space cross ties 24 to the 39 foot rail for mainlines, access tracks or other tracks where the movement may be classified as heavy. Space cross ties 20 to the 39 foot rail for body tracks in yards, sidings, running tracks and access tracks where the movement is not classified as heavy. Space switch ties and bridge ties as indicated. Use oak cross ties in road crossings. All curved track should have oak ties installed. All curved track should have as a minimum 6 oak ties spaced uniformly among the number of ties required. Lay ties normal to the centerline of the track with the wide heartwood face down. Provide the best ties at rail joints. Do not move or place ties with picks, shovels, mauls, sledges, or spiking hammers. Make ends of ties on one side of the track parallel to the rail so that center of tie will be on the approximate centerline of the track. Align the ends on the inside of curves and continue on that side until reaching a curve in the opposite direction. On double tracks, align the ties on the outside ends. Provide full bearing for tie plates. Restrict adzing to that necessary to provide a sound true bearing for the tie plate. Where necessary to adz, dap or drill holes in the timber tie. Saturate cut surface with creosote or other approved preservatives.
2. Precast Concrete Ties: Provide ties in accordance with AREMA Ch. 30.

D. Tie Plates: Place tie plates with full bearing on the tie. Tie plates shall be free of dirt and other foreign material when installed. Set tie plates at right angles to the rail with the outside shoulder against the

base of the rail, and centered on the tie. Place tie plates so that the rails will have full bearing on the plate and the plate will have full bearing on the tie.

E. Tie Pads: Place pad on concrete tie so that rail will have full bearing on tie pad.

F. Rails: Clean base of rail and tie plate prior to laying. Lay rails without bumping or striking to standard gage 4 feet 8 1/2 inches on tangents and on curves up to 12 degrees. Widen gage on curves greater than 12 degrees, 1/8 inch for each additional increment of 2 degrees above 12 degrees to a maximum gage of 4 feet 9 inches. Gage the track normal to the rails at joints, centers, and quarters as spikes are being driven. Stagger joints in opposite rails not less than 13 feet apart, except closer joints may be required at turnouts or insulated joints. Rails of less than standard length may be used, but no less than 13 feet, to space the joints on curves. No joint shall be less than 6 feet from the ends of open-deck bridges, or less than 3 feet from switch points. Do not install joints within 20 feet of a road crossing, outer perimeter of structure, or location which restricts access to the joint. Where joints are required in these areas, the joints shall be welded. Provide allowance for thermal expansion at bolted rail joints by using rail-expansion shims of wood, fiber, or metal. Remove shims to within 12 rails of the laying. Provide shims of the thickness, based upon rail temperature during construction, as shown in Table IV. Determine the temperature of the rail by use of a thermometer placed on the base of the rail in the shade. Use rail saws to cut rail. Drill new holes. Holes cut with a torch will not be acceptable. Adjacent relayer rails shall be matched to prevent lipped or uneven joints, and any mismatched rail ends shall be ground or built-up welded.

TABLE IV - SHIM THICKNESS

33 Foot Rail		39 Foot Rail		78 Foot Rail	
Rail Temperature, Degrees F	Shim Thickness, Inches	Rail Temperature, Degrees F	Shim Thickness, Inches	Rail Temperature, Degrees F	Shim Thickness, Inches
Below -10	5/16	Below 6	5/16	Below 35	5/16
10 to 14	1/4	6 to 25	1/4	35 to 47	1/4
15 to 34	3/16	26 to 45	3/16	48 to 60	3/16
35 to 59	1/8	46 to 65	1/8	61 to 73	1/8
60 to 85	1/16	66 to 85	1/16	74 to 85	1/16
Over 85	None	Over 85	None	Over 85	None

G. Joint Bars: Coat clean joint bars with petroleum or petroleum based compound with a corrosion inhibitor. Rail joints shall be installed so that the bars are not cocked between the base and head of the rail. Base shall be properly seated in the rail and the full number of correct-size bolts, nuts, and spring washers installed. Apply corrosion resistant grease to the bolt threads prior to application of nuts. Place bolts with nuts alternately on inside and outside of rail and draw tight before spiking. Bolts shall be tightened at the center of the joint and working both ways to the ends of the joint. At initial tightening, make bolt tension 20,000 to 30,000) lbs/bolt. After track has been in service and before acceptance of the work, check all bolts and tighten. Allow two threads of all bolt lengths to protrude from the nut after tightening. Connect rails of different sections by properly fitting compromise joint bars. The mismatch for compromise joints for either tread surface or gage side alignment shall not exceed 1/16 inch.

H. Welding Joints

1. Welded Rail Joints: Properly clean rails of foreign substances such as dirt, grease, loose oxide, and slag, prior to welding. Rail ends shall be properly aligned with the provisions for proper joint gap, and lateral and vertical positioning of the rail ends. Proper joint gap and positioning of rail ends shall be in accordance with the recommendations and specifications of the manufacturer and supplier of the particular welding process used, all subject to prior approval by the Owner. Weld rail in an approved manner and by workmen familiar with the welding method used. Do not weld when the rail temperature is lower than that recommended for the welding method used. Welding together of rails which have been drilled for bolted joints will not be permitted. Rail joints except those joints at fittings shall be welded. Use the thermite self-preheat method **OR** manual shielded-arc welding method, **as directed**.
   a. Thermite Self-Preheat Method: See Division 34 Section “Welding Crane And Railroad Rail-thermite Method" for specifications.
   b. Manual Shielded-Arc Welding Method: Use this process in accordance with applicable provisions of the AWS WHB-2 CH 2 and the following instructions:
      1) Rail end preparation: Bevel the ends of the rails at approximately 35 degrees full bevel on the head, 35 degrees double bevel on the web, and 35 degrees full bevel on the upper side of the base. Retain a narrow "nose", approximately 1/16 inch, of the original rail-end face across the base and up the web following the beveling operation, to permit proper alignment of rail ends. When beveling with a torch, first preheat each rail end to 500 degrees F. After torch cutting, grind off scale and oxides. Grind level faces only after preheating. Use proper grinding wheel and speed to avoid grinding "burns" or formation of "hard spots" from localized overheating.
      2) Alignment of rails: Align the beveled rail ends, allowing approximately 1/8-inch root clearance, and place a copper shim under the joint opening. Clamp the rails during the welding with up to 1/4-inch vertical camber (ends high) in four feet, centered over the joint to compensate for contractional distortion.

3) Preheating joints: Preheat the joint area to approximately 500 degrees F for a distance of 6 to 8 inches on each side of the joint, using a suitable heat source such as an oxy-acetylene or propane torch.
4) Arc welding: Initiate welding of the joint immediately after preheating in the following sequence: base, web and head. Weld alternately on both sides of the base and web. Do not entrap foreign material, such as slag, in the weld. Ground, chip, or arc-air the root of the initial weld to sound metal before welding is started from the second side. Maintain a 500 degrees F to moderately higher interpass temperature. Proceed with welding until the joint is completed and sufficient metal has been deposited to permit grinding to finish contour in the head area. Provide slight reinforcement of the web and top of base areas.
5) Postheating of welds: Postheat the joint area to approximately 700 degrees F immediately after the welding operation, using the same technique for preheating. After postheating, protect the weld area against rain and snow and cool as slowly as possible by covering with an insulating blanket.
6) Grinding of welds: Remove the excess deposited weld metal from the sides and top of the rail head using a heavy-duty grinder. Grind the area smooth, finishing closely as practical to the original contour. Use proper grinding wheel, speed, and rate of metal removal to avoid grinding "burns" or formation of "hard spots" from localized overheating. Exercise care to prevent grinding cracks.
7) Temperatures: Measure the temperatures as indicated herein by temperature pencils.

c. Electric Flash-Butt Method: Welding process shall conform to applicable provisions of AREMA Ch. 4-3.

I. Spiking Wood Ties: Spike rail promptly after laying. Do not remove gage until spikes are driven. Start and drive spikes vertically and square with the rail and allow about 1/8 inch space between spike head and rail base. Provide four rail-holding spikes on each tie on tangent track and on curved track up to 6 degrees of curvature; spikes being staggered with outside spikes in each tie near the same edge, and inside spikes near opposite edge of tie with position of spikes the same on ties requiring four spikes. Provide six rail-holding spikes on each tie on curves of larger than 6 degrees of curvature, one on outside and two on inside of each rail. Provide eight rail-holding spikes on each tie through road crossings. At joints, hold rail in place by reversing the normal position of the spike when it is driven.

1. Plate Holding Spikes: Plate holding spikes shall have pilot holes predrilled in accordance with AREMA Ch. 30. Swab field-drilled pilot holes with creosote prior to spiking.
2. Tie Plugs: If spikes are withdrawn, swab the holes with creosote and plug with creosoted tie plugs of proper size to fit the hole. If spikes are withdrawn and spikes are to be re-inserted in existing spike holes, the holes shall be swabbed with creosote and plugged with creosoted tie plugs prior to re-driving the spike.

J. Fastening Concrete Ties: Install fastenings for concrete ties in accordance with manufacturer's recommendations. Protect exposed portions of fasteners from corrosion.

K. Turnouts And Crossovers: Locate turnouts and crossovers as indicated. Frog, switch, and guard-rail assemblies shall be complete. Accurately bend stock rails. A switch point protector shall be provided at each switch, on the rail as required to meet project requirements. Place headblocks at right angles to the main track and securely spike. Except where directed otherwise, set switch stands on the closed-point side when the switch is in normal position. Adjust switches properly. Swab turnout fixtures with oil. Changes in rail section will not be permitted within the limits of switch ties.

L. Accessories

1. Rail Anchors: Locate as indicated. Apply 16 anchors per 39 feet of rail in the pattern indicated in accordance with AREMA recommendations for "Light Density Lines" in AREMA Ch. 5. Distribute anchors uniformly along rail without application on joint ties. Install rail anchors on gage side of rail against same tie face on opposite rails. Rail anchors shall grip the base of the rail firmly and shall have full bearing against face of tie. Rail anchors shall not be removed by driving them

along the rail. Rail anchors shall not be applied to track on an open-deck bridge. Where anchors are applied on track approaching an open-deck bridge, every third tie shall be box anchored for at least two rail lengths off each end of the bridge.

2. Guard Rails: Install guard rails on curves, bridges and trestles in accordance with AREMA PTWP. Bridge guard rails shall be approximately 11 inches from gage side of track rails, and shall extend a minimum of 30 feet beyond the structure. Ends shall be curved inward and beveled. Fully bolt guard rails. Guard rails shall not be higher than the running rails, and shall not be more than one inch lower than the running rail. Each guard rail shall be spiked with two spikes to each tie, but shall not be tie-plated. Unfit track rail in short lengths can be used for guard rails. Relay rail of the same size as the running rail may be used if it meets the requirements of MIL-R-3911.
3. Derails: Install derails where indicated. Place derails so that derailed equipment will not foul other tracks.
4. Bumpers and Wheel Stops: Install bumpers and wheel stops where indicated.

M. Ballast Distribution
1. Subballast shall be installed if required and as required to meet project requirements.
2. Geotextile fabric shall be installed if required and as required to meet project requirements.
3. Ballast shall not be distributed until area where ballast is to be installed has been approved by the Owner. No ballast shall be distributed without the Owner's approval. Ballast distribution shall be to depth indicated and may be from either trucks or railroad cars. Take care when distributing ballast from automotive equipment to prevent forming of ruts that would impair proper roadway drainage. Ruts formed that would impair drainage shall be leveled and graded to drain. Excess ballast shall be picked up and redistributed at the Contractor's expense. If additional ballast is required for dressing, it shall be added by the Contractor at no increase in price. No ballast cars shall be released until they have been inspected by the Owner. Cars may be weighed by the Owner at no cost to the Contractor.
4. Install Size No. 3, 4, or 4A for mainline ballast and Size No. 5 or 57 for yard and house tracks. Depth shall be as required to meet project requirements.

N. Surfacing
1. Superelevation: Superelevate curves as shown unless otherwise as required to meet project requirements. Obtain superelevation by raising outside rail of curve. Maintain inside rail at grade. Maximum superelevation shall be 6 inches. Full superelevation shall be carried throughout each curve, unless otherwise directed or shown. Superelevation runoff shall be at a uniform rate, and shall extend at least the full length of the spirals. The normal rate of superelevation runoff will be 1/2 inch in 31 feet; however, this may be increased to one inch in 31 feet with prior approval of the Owner.
2. Preliminary Surfacing: Perform preliminary alignment and surfacing after unloading of ballast. After preliminary alignment, bring the track to grade and surface in lifts not exceeding 6 inches each. After each lift, tamp the ballast. Place jacks close enough together to prevent undue bending of rail or stress of rail and joint. Raise both rails uniformly except where superelevation is required. Power tamp ballast under both sides of cross ties from each end to a point 15 inches inside each rail. Fill the center with ballast, but do not tamp the center between the above stated limits. Tamp both ends of the cross ties simultaneously, including tamping inside and outside of the rail. Regardless of the kind of ballast or the kind of power tamper used, work tamping tools opposite each other on the same tie. Tamp ballast under switch ties for the entire length of each switch tie. After tamping has been completed and jacks removed, re-spike loose ties securely in proper position with full bearing on tie plates.
3. Final Surfacing: After preliminary surfacing has been completed, or for track being repaired, where preliminary surfacing is not required, check line and grade stakes, operate engine and equipment over track, and align track. Bring track to grade and re-tamp ballast in the manner described for preliminary surfacing. Decrease tamping distance inside rail on cross ties from 15 to 13 inches. Give track a final lining conforming to established track centers. Dress ballast to section indicated and bring subgrade shoulders to line and surface.

4. Final Adjustments: Sixty calendar days after track has been accepted and put in operation, the Contractor shall perform necessary resurfacing adjustments without cost, to leave the track in alignment and on grade.

O. Tolerance: Completed track shall meet the following tolerances. Repair track not meeting the tolerances specified below to meet the requirements at no additional cost to the Owner.
   1. Alignment: Shall not deviate from uniformity more than the following prescribed amounts:
      a. Tangent Track: Change between any adjacent 31 foot stations measured at the mid offset from a 62 foot line may not be more than 1/2 inch from the gage line. (The gage line shall be defined as the line on the gage side of the line rail, 5/8 inch below the top of the centerline of the railhead. Either rail may be used as the line rail; however, the same rail must be used for the full length of the tangential segment of track.)
      b. Curved Track: Change between any adjacent 31 foot stations measured at the mid-ordinate from a 62 foot chord may not be more than 3/8 inch for 36 degree curves and flatter. For curves greater than 36 degrees, change between any adjacent 15 1/2 foot stations measured at the mid-ordinate from a 31 foot chord may not be more than 1/2 inch. (The ends of the chord must be at points on the gage side of the outer rail, 5/8 inch below the top of the railhead.)
   2. Track Surface: May not deviate from uniformity more than the amount prescribed below:
      a. Runoff in any 31 foot of rail at the end of a raise may not be more than 1/2 inch.
      b. Deviation from uniform profile on either rail at the mid-ordinate of a 62 foot chord may not be more than 1/2 inch.
      c. Deviation from designated elevations on a spiral may not be more than 1/2 inch.
      d. Deviation in cross level in spirals in any 31 foot may not be more than 1/2 inch.
      e. Deviation from zero cross level at any point on tangent or from designated elevation on curves between spirals may not be more than 1/2 inch.
      f. Difference in cross level between any two points less than 62 foot apart on tangents and curves between spirals may not be more than 5/8 inch.
   3. Gage
      a. Track Gage: Within plus 1/4 inch of standard gage in tangent track and curves less than 12 degrees.
      b. Curved Track: For curves larger than 12 degrees, lay rail to within plus 1/4 inch or minus 1/8 inch of required gage.
      c. Guard Face Gage: Distance between guard lines measured across the track at right angles to gage line, and is measured at the point of frog on both sides of the turnout. Design value for guard face gage is 52-3/4 inches. Guard face gage shall be within plus or minus 1/4-inch of design value.
      d. Guard Check Gage: Distance between gage line of a frog and guard line of its guard rail, or guarding face, measured across the track at right angles to the gage line. The design value for guard check gage is 54-5/8 inches. Guard check gage shall be within plus or minus 1/8-inch of design value.

P. Railroad Crossing: Install bituminous, wood plank, prefabricated sectional treated timbers, or rubber crossing as indicated, and in accordance with manufacturer's recommendations and specifications.

Q. Bonding And Grounding Track: Track shall be bonded and grounded as indicated. Where track is designated for bonding and grounding, rails shall be bonded electrically continuous and effectively grounded. The grounding system shall consist of ground conductors and ground rods. Make connections by the exothermic weld process in accordance with manufacturer's instructions. Maximum resistance to ground from grounded rail or structure shall not exceed 10 ohms. When work, in addition to that indicated or specified, is directed in order to obtain the specified ground resistance, the provision of the contract covering "changes" shall apply.
   1. Rail Joint Bond: Bond rail joints on both rails of each track. Bond rails together with not less than No. 1/0 AWG 3/8-inch diameter bare stranded soft drawn copper conductor. Track to be bonded and grounded shall be electrically isolated from the remaining track.

2. Rail Cross-Bond and Ground: Rail cross-bond and ground shall be as indicated. Make connections between grounding system or ground rods and rails with a minimum No. 1/0 AWG bare stranded soft drawn copper cable, installed at least 12 inches below the bottom of the ties. Ground rods shall be 3/4-inch diameter copper-clad steel rods. Rods shall have a hard, clean, smooth, continuous copper surface and the portion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of 0.013 inch at any point in the rod. Each ground rod shall be die-stamped near the top with the name or trademark of the manufacturer and the length of rod in feet. Connection of conductors to the ground rods shall be by all bronze, U bolt type ground clamp. Ground rods shall be a minimum of 10 feet long and shall be driven vertically full length. Provide one cross-bond and ground for each section of bonded and grounded track.

R. Supplementary Installations: Furnish and install permanent signs and signals such as crossing, clearance, derail and other safeguards in accordance with recommended practice of the AREMA.

S. Field Quality Control
   1. Inspection of Rail Welds
      a. Visual Inspection: Inspect new rail fittings thoroughly. Pay particular attention to any defect that might hinder satisfactory operation. Inspect bolted joints for loose bolts and smooth transitions between rails of different sections. Inspect each welded joint thoroughly after removal of mold and grinding of excess metal. Pay particular attention to surface cracking, slag inclusion, gas pockets, and lack of fusion. Correct or replace parts of welds found defective. Method of correction shall be as approved by the Owner.
      b. Ultrasonic Inspection of Welded Rail Joints: Inspect each weld ultrasonically following the visual inspection. the Owner will test each weld ultrasonically following the visual inspection. Inspect and test in accordance with MIL-STD-1699. Clean rails at testing locations as directed by the Owner. The Contractor is responsible for the correction or replacement of defective parts or welds. The method of correction shall be as approved by the Owner.
   2. Inspection of Track: Perform tests to verify gage, alignment, cross level and grade at least once every 100 feet or less of track centerline length. Measure gage between points on inside of rails, 5/8-inch below top of railhead.

END OF SECTION 34 01 23 33

SECTION 34 01 23 33a - WELDED TRACK RAILS

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of continuous welded rail, and continuous welded rail. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control: Construction Equipment: Subject to inspection and acceptance by the Owner. Track equipment shall satisfy clearance requirements of Exhibit G of this Section, and shall have tapered wheels and a wheel gauge of 56-11/16 inches.
1. Rail tester: Automation Industries, Inc., Sperry Div.'s SRS Car 802, or accepted equivalent.
2. Rail grinder: Rail-mounted, self-propelled, high-speed type capable of removing at least 0.001 inch of metal per pass after track has been installed; Fairmont Railway Motors, A Division of Harsco Corp.'s RGC-24-A-1, or accepted equivalent. Diameter of grinding wheel shall be not smaller than 10 inches. Downward pressure of grinder shall be controllable to the extent that more metal may be removed per pass at high spots and that low spots shorter than five inches may be bridged.
3. Track geometry car: Capable of measuring deviation from track construction tolerances indicated in Exhibit H of this Section, and of recording those deviations; System Sciences Inc.'s EM-25 Hy-Rail Geometry Car, or accepted equivalent.

1.2 PRODUCTS

A. Tags: Brass or anodized aluminum; 1-1/4 inches wide by two inches long by 0.050 inch thick; and stamped with numerals 3/4 inch high, except that numerals for fractions shall be 3/8 inch high.

B. Adhesive For Bonding Tags To Concrete: Either Tru Loc United of Dublin's TRU LOC Epoxy No. 135, or DevCon Corp.'s 2-Ton Clear Epoxy Stock No. 14310, or accepted equivalent.

C. Paint: Yellow alkyd primer; FS TT-P-645.

D. Welding Material: Full penetration, complete fusion thermit type.

1.3 EXECUTION

A. Examination
1. Inspect CWR before loading CWR onto rail train; accept only undamaged CWR. Replace in-kind CWR which becomes damaged and stolen after Contractor has accepted CWR.
2. Examine ties before laying CWR; ensure that ties are free from ballast and that inserts contain no debris.

B. Laying CWR
1. Lower CWR onto tract, and with gauge side of CWR facing centerline of track. If CWR will be cut, paint a six- inch stripe on gauge side of each sawn rail. After CWR has been placed, arrange ends of opposite CWR to be more than ten feet from the ends of the placed CWR when measured along centerline of track, and arrange field weld to be more than 10 feet from weld in opposite CWR, more than 14 feet from shop welds in same CWR, and more than 14 feet from center of bonded joints. Align gauge side of CWR in tangent track to be equidistant from track centerline, and align gauge side of low CWR in curved track to be 28-1/4 inches from track

centerline. Do not strike rail with metal objects. If rail ends will be welded, align rail ends with a rail alignment beam. Record weight, mill-brand, rolling year, and heat number of end rails in CWR; date and time of placing CWR; length of CWR; air and rail temperature; stationing of both ends of CWR; and weather conditions. Place thermometer on shaded side of CWR base next to web and allow thermometer to remain there until no change in temperature is detected, but for not less than five minutes, then read and record temperature and remove thermometer.

a. If CWR will be bolted to abutting CWR, saw-cut end of CWR in which pulling hole has been drilled; sawcut one inch from hole away from end of CWR and perpendicular to CWR, then discard portion containing hole. Cut off bent rail ends of CWR square and clean with either rail saw or abrasive cutting disc. Bevel end of CWR in accordance with AREA Standard Plan Number 1005-40, and drill bolt holes perpendicular to web of CWR using template as drilling guide. If rail is not heat-treated carbon type, harden and chamfer end of CWR by methods and with results specified in AREA MRE, Chapter 4, Part 2, Supplementary Requirement S1.

b. If CWR will be welded to abutting CWR, remove burrs and lipped metal from end of CWR, then remove loose oxide, scale, and foreign material from within six inches of end of CWR.

2. Gapping CWR

a. At Joints to be welded: Align CWR with abutting CWR, and adjust end of CWR to be thickness-of-field-weld away from abutting CWR.

b. At Joints to be bonded: Calculate gap width by the formula:

$G = 0.000078L(t-T) + Q$

where G = gap, in inches.
L = length of CWR, in feet.
t = 60 degrees F if rail will be anchored in subway;
75 degrees F if rail will be anchored in Station undercover;
80 degrees F if rail will be anchored elsewhere.
T = temperature of rail when being anchored.
Q = 0.125 inch if joint will be noninsulated; end post thickness otherwise.

c. Align CWR with abutting CWR, adjust end of CWR to be width-of-gap away from abutting CWR, and, if gap will be wider than 1- 1/2 inches, insert a dutchman 1/2 inch shorter than width of gap. Remove dutchman before anchoring rail and if it is anticipated that rail will become warmer before being bonded.

C. Temporarily Anchoring CWR: If CWR is either on tangent or on curves the radius of which is larger than 1,900 feet, anchor CWR, by either rail clips or track spikes, at track gauge on every fifth rail fastener or tie plate. CWR on curves with radius of less than 1,900 feet, anchor CWR, by either rail clips or track spikes, at track gauge on every third rail fastener or tie plate. Anchor CWR to tie plates with track spikes and insulators at grade crossing and with rail clips and insulators on concrete ties. Anchor CWR to rail fasteners with bolted rail clips at hi-rail access.

1. Drive track spikes adjacent to and along both sides of each CWR base with insulator placed between rail and track spike.
2. Anchor CWR to concrete ties with rail insulators placed on rail base and driving rail clips in tie embedded rail shoulders.
3. Anchor CWR to rail fasteners at hi-rail access with rail clips inserted in rail fastener, and torque clip bolt to 250 pounds.

D. Joining CWR: Remove rail clips within 300 feet of joint to be welded and of joints to be bonded. Weld ends of CWR indicated to be welded. Bond ends of CWR indicated to be bonded; if a dutchman has been inserted at joints to be bonded, remove dutchman.

1. Welding

a. Weld in accordance with Specifications for Fabrication of Continuous Welded Rail in Chapter 4, Part 2 of AREA MBE except that running surface shall have a crown ensuring that top of weld is smooth and flat after weld has cooled and excess weld has been ground off. Welding will be acceptable if it satisfies the requirements of Du-Wel Steel Products Co.'s Recommended Procedures for Boutet Process Quick Preheat Thermit Rail Welding.

b. Finish weld by methods and with tools not causing weld to become hotter than 1077 degrees F. Remove surplus metal from hot rail head weld with a mechanical or hydraulic rail- shearing device. Trim and finish welds with a profile grinder. When measured with a three-foot metal straightedge, portions of rail shall be within the following tolerances:
   1) Top and sides of rail head: Within plus 0.03 inch and minus 0.00 inch of parent rail section.
   2) Rail base: Within plus 0.01 inch and minus 0.00 inch of the parent rail section, only for welds which are within three inches of edge of rail fasteners and tie plates.
   3) Rail web and remainder of rail weld: Within plus 0.125 inch and minus 0.00 inch of the parent rail section.

c. Reinstall rail clip on fastener from which removed.

d. Remove oxide, scale, and foreign material from web of rail on both sides of CWR and for three inches on one side of field weld. Paint a two-inch wide stripe one inch from weld the full height of the web on gauge side of CWR and along the base of CWR.

2. Bonding: TRACK APPURTENANCES.

E. Measuring Rail Alignment At Shop Welds: Using a steel straightedge and a tapered gauge specified, measure the horizontal and vertical alignment of each string of CWR on both sides of rail head at each shop weld and at points 5/8 inch below top of rail and on top of rail along its centerline. Record measurements at center of welds and at points six inches and 18 inches each way of the weld to the nearest 0.001 inch.

F. Grinding And Removing Shop Welds: If the Owner judges that a shop weld in CWR is misaligned, the Owner will order weld be ground or removed. If the Owner orders weld be ground, grind weld and adjacent rail to the extent determined by the Owner, but not more than 1/16 inch thickness. If the Owner orders weld be removed, saw-cut rails 1/2 inch from each side of weld, field-weld ends of CWR, and finish welds in accordance with directions by the Owner.

G. Permanently Anchoring CWR: Anchor CWR on aerial structures, in tie- and-ballasted track, in subways, and through station platforms only if temperature of CWR is as specified.
1. Mechanically vibrate CWR and loosen rail clips that have been temporarily fastened at every third or fifth tie or rail fastener and in increments of 500 feet. Set CWR to horizontal and vertical alignments within construction tolerances as directed by the Owner.
2. Continue vibrating CWR as remainder of rail clips are being permanently installed.
3. Record rail-anchoring data include type of adjustment by which zero stress in CWR was achieved and end movement of CWR at 30- minute intervals or at 200-foot lengths of track when rail is being anchored.
4. After CWR has been finally surfaced, rail fasteners shall be laterally adjustable not less than 1/4 inch in both directions.

H. Testing
1. CWR and shop welds: Ultrasonically test CWR and shop welds with a track inspection car. Identify each test with the Project number and title, date, testing agent, and location by station.
2. Field welds: Test field welds ultrasonically by the multiprobe pulse-echo technique, and with the Kroutkrame USK-7 tester or accepted equivalent.

I. Adjusting: If shop weld is determined to be defective by ultrasonic testing, remove weld by saw cutting CWR not less than one inch on both sides of the weld, making another cut in CWR not less than 20 feet from weld, and installing new section of rail with two field welds; or cutting out a section of CWR equal distance each way from shop weld.
1. If weld and section of CWR is on tangent track, furnish and install a rail not shorter than 14 feet and field-weld that rail to installed CWR.
2. If weld and section of CWR is on curved track, furnish and install a rail not shorter than 39 feet and field-weld that rail to installed CWR.

J. Installing Tags: Install one foot inside superelevated CWR, and orient tag to be read in ascending order from tangent to spiral to spiral to curve.
   1. If concrete surfaces of tag locations are rough, grind surfaces smooth. Remove laitance, dust, and clean concrete surface.
   2. Apply epoxy to back of tags, and tags on track concrete surfaces and on concrete ties at beginning and ending points of curved track and at elevation increments of 1/4 inch within spirals and curves.

K. Grinding CWR: Grind top of rail head not fewer than three times and in a continuous operation, all within three days after starting to grind. Remove not less than 95 percent of rust and mill scale.

L. Adjusting Track: Eliminate track deviations, as disclosed by the Owner's analysis of as-built survey data and final track inspection, exceeding specified tolerances.

M. Clean-Up: Remove debris, excess rail, spilled concrete, and clusters of grinding particles. Cut exposed tie wires and stirrups flush with concrete surfaces, remove cuttings.

END OF SECTION 34 01 23 33a

SECTION 34 01 23 33b - THERMITE WELDED TRACK RAIL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of welding crane and railroad rail -thermite method. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit the following.
1. Samples
   a. Operator qualification welds
   b. Procedure qualification welds
2. Test Reports
   a. Ultrasonic tests
   b. Hardness tests
3. Certificates
   a. Rails
   b. Welder's qualification
   c. Welding procedure
   d. Cold weather welding procedures
   e. Wet weather welding procedures
   f. Rail correction method
   g. Rail preparation
4. Manufacturer's Instructions: Thermite kit
5. Closeout Submittals: Submit welded joint records as required by paragraph entitled "Joint Records."

C. Quality Assurance: Use only qualified procedures and personnel. Procedures and personnel previously qualified in accordance with this specification shall not require requalification, provided qualifications have not lapsed and qualification records are available.
1. Operator Qualification: The Contractor shall notify the Owner in writing one week prior to making qualification welds. Operators shall qualify by welding one acceptable rail joint in accordance with a qualified procedure. This qualification may be accomplished either prior to production welding or on the first joints to be welded at the work site. If welding operator qualification is conducted at the work site, perform no further welding until the qualification weldments have been accepted by visual inspection and ultrasonic tests. Written approval of the acceptability of the welded joint shall be obtained from the Owner prior to continuing with welding. Welding operator's qualification shall be effective from the test date and will remain in effect for a period of one year.
2. Acceptable Welds: Shall be those welds that meet the visual inspection and ultrasonic test requirements of MIL-STD-1699. Welds selected for testing for Brinell Hardness shall meet the requirements of ASTM E 10 and paragraph entitled "Hardness Test."
3. Procedure Qualification
   a. Written Procedure: Prepare for the welding process to be used. The procedure shall include the information specified in paragraph entitled "Submittals," as well as any particulars of the process deemed pertinent to the successful completion of the welds.
   b. Manufacturer's Procedure: No separate qualification is necessary for various rail weights, although in order to be qualified for a specific rail weight or cross section, the procedure shall include fit-up requirements and other features unique to the rail weight or cross section of the rails to be welded.
   c. Welding Procedure Qualification

1) Provide welding procedure qualification records acceptable to the Owner as proof of previous qualification under this specification. The records shall include the information specified in paragraph entitled "Submittals," as well as any particulars of the process deemed pertinent to the successful completion of the welds.
2) Welding procedure not previously qualified under this specification may be qualified by providing four consecutive acceptable welded rail joints. An acceptable weld is defined as a weld which has been visually inspected and ultrasonically tested and has been found acceptable in accordance with MIL-STD-1699 and ASTM E 10. This qualification may be accomplished either by shop fabrication of the joints or on the first four joints welded at the work site. If procedure qualification is accomplished at the work site, perform no further welding until the qualification weldments have been accepted by visual inspection and ultrasonic tests. Obtain written approval of the acceptability of the four welded joints from the Owner prior to continuing with welding.
3) Ambient temperature: Welding procedure shall be considered qualified for use at an ambient temperature of 50 degrees F and above regardless of ambient temperature during welding of qualification assemblies. No welding shall be conducted below 50 degrees F without a specifically qualified procedure. Procedures qualified for use at ambient temperatures less than 50 degrees F shall be qualified by welding test assemblies in accordance with the procedure qualification requirements of this specification at the desired minimum ambient temperature plus or minus 5 degrees F. Procedures thus qualified shall be considered acceptable for use at the minimum qualified ambient temperature and above.
4) Wet weather welding: Perform welding only during dry weather. No welding will normally be permitted on wet, showery and inclement days. However, if means are provided to protect the work and work area, welding may be performed during other than dry weather, if approved by the Owner. Welding in confined spaces shall comply with AWS D1.1 to assure adequate ventilation for personnel safety.

4. Required Data: Submit thermite kit manufacturer's instructions and recommendations covering rail end preheat treatment, thermite ignition, mold removal, and finishing.
5. Welding Procedure
   1) Thermite kit manufacturer's name and kit size or designation
   2) Thermite kit batch numbers and manufacturing date
   3) Welding procedure designation (name, number)
   4) Size of rail section being joined and type of rail
   5) Test assembly identification number
   6) Results of nondestructive testing of qualifications assemblies
   7) Date of qualification (test date)
6. Required Qualification Welds: Submit operator qualification welds in accordance with paragraph entitled "Operator Qualification." Submit procedure qualification welds in accordance with paragraph entitled "Welding Procedure Qualifications." Include results of ultrasonic test and hardness tests. Welder’s certification or procedure qualification may be substituted, pursuant to paragraph entitled "Quality Assurance."

D. Delivery And Storage: Deliver materials in the manufacturer's original unbroken packages or containers plainly labeled with the manufacturer's name and brand.
1. Receipt Inspection of All Thermite Weld Kits: Shall consist of a visual inspection of the weld kit package for freedom from damage and the recording of the thermite weld mix batch number and manufacturing date. Do not use kits which have been manufactured more than 2 years before the date of use or show signs of having been wet.
2. Material Control: Store materials in the original package and keep dry at all times until used.

1.2 PRODUCTS

A. Materials: Provide in kit form including preformed mold, thermite powder, wicking cord, luting material, and all necessary materials and accessories needed to provide one welded rail joint per kit. Molds shall be factory-made, moisture free, and of nonhygroscopic material.

1.3 EXECUTION

A. Sequence Of Operation: Perform work in strict accordance with the qualified procedure.
   1. Rail Preparation: Cut rails which are battered, cracked or notched, or which contain bolt holes so that these irregularities are removed. Rail surface shall be free of grease, dirt, loose oxide, and moisture on the face of and for approximately 5 inches from the joint to be welded. Clean rail ends by grinding or wire brushing. Use a torch to remove grease, oil, or moisture in accordance with procedures in thermite manufacturers instructions. Rail cutting, when necessary, shall be by the saw-cut method. Remove all burrs, rolled-over edges, and loose oxide before applying the mold. No flame cutting of rails is permitted. If the space between the mold and the rail is unusually large on used or relayer rails, fill this gap with a piece of wicking cord before luting or packing.
   2. Rail Alignment: Separate rail ends as recommended by the welding process manufacturer. Align rails as to both surface and gage, and raise the rails at the joint to compensate for the greater thermal contraction that occurs in the rail head during cooling relative to the web and base regions. Measure the amount of joint elevation with a 36 inch long straightedge centered at the joint. The correct elevation is obtained when 1/16 inch separates the top of the rail head and bottom surface of the straightedge at both ends.
   3. Placing of Molds: Attach the molds to the rails, centered over the joint, and seal the molds to the rail with luting material according the welding kit manufacturer's instructions. Handle the luting material, a mixture of clay and sand, so that none is introduced into the weld chamber. Align so that the centerline of the mold coincides with the centerline of the gap. Install the tapping plug or discs in the crucible and pour in the prescribed amount of thermite mixture.
   4. Preheating Rail Ends: In accordance with the manufacturer's instructions and recommendations.
   5. Ignition of Thermite: Follow manufacturer's instructions and recommendations.
   6. Mold Removal: Follow manufacturer's instructions.
   7. Finishing: Follow manufacturer's instructions and recommendations. No finishing is required on the web and base of rail. Perform final grinding when the weld and rail have cooled to ambient temperature. Under no circumstances shall a cutting torch be used to remove excess weld metal.
   8. Joint Records: Provide a record of the date and location of each weld made. The record shall also include the rail type, size, thermite kit manufacturer's name, and thermite weld portion batch number. Also, provide a record of the nondestructive test date and acceptance date.

B. Inspection And Testing
   1. Visual Inspection: Each welded joint shall be inspected by the Contractor after removal of the mold and grinding or removal of excess metal. The inspector shall pay particular attention to surface cracking, lack of fusion and other surface irregularities. The Contractor shall correct or replace all defective welds at no additional cost to the Owner. The method of correction shall be approved by the Owner.
   2. Nondestructive Inspection: Inspect each welded joint by ultrasonic tests using the method of inspection and acceptance as prescribed in MIL-STD-1699. The Contractor shall correct or replace all defective welds at no additional cost to the Owner. The method of correction shall be approved by the Owner. All repairs to defective welds shall be ultrasonically inspected by the Contractor using the method of inspection and acceptance as prescribed in MIL-STD-1699.
   3. Hardness Tests: Perform Brinell hardness test in accordance with ASTM E 10 and ASTM E 110. The Brinell Hardness Number (BHN) of the weld and for the rail for a distance of 6 inches on each side of the joint shall be greater than 250. In the heat-affected zone (a distance not greater than one inch to each side of the joint) the BHN may be up to 20 points lower except for the top of the rail, which shall be not less than 250. Check hardness on at least 10 percent of all welds. Tests shall be performed on randomly selected welds or as directed by the Owner.

END OF SECTION 34 01 23 33b

SECTION 34 01 23 33c - DIRECT FIXATION TRACK

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of direct-fixation track. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control
1. Construct a complete section of direct-fixation track not shorter than 250 track feet; construct within trackway and where required by the Owner. Section constructed as indicated will become a part of the permanent track; otherwise, remove section and construct another section until section is constructed as indicated.
2. If inserts will be installed in a hole cored into the track concrete, furnish services of grout manufacturer's representative for one working day at start of coring operations. Representative shall inspect cored hole; if hole is acceptable to representative, representative shall enforce grout manufacturer's mixing and installation procedures and methods and witness the placing of grout and inserts.

1.2 PRODUCTS

A. Grout: Premeasured, prepackaged, cement-based, nonmetallic, nonshrink type; CRD C621. Retemper only in accordance with manufacturer's printed instructions. Water shall be potable.
1. Shrinkage
a. Grout for repairing voids in track concrete: Zero percent shrinkage in plastic state and not more than 0.1 percent expansion in hardened state when tested in accordance with CRD-C621, Sections 10.1 and 10.2.
b. Grout for setting anchorage inserts: Zero percent shrinkage and expansion in plastic and hardened states when tested in accordance with CRD C621, Sections 10.1 and 10.2.
2. Compressive strength, when tested in accordance with CRD C621:
a. Grout for repairing voids in track concrete: 5,000 psi at end of 28 days.
b. Grout for setting anchorage inserts: 2,000 psi at end of seven days.
3. Initial setting time, when tested in accordance with ASTM C191:
a. Grout for repairing voids in track concrete: Not sooner than 60 minutes.
b. Grout for setting anchorage inserts: Not sooner than 10 minutes.

B. Shims: ASTM A 167, UNS S30400; and 1/16-, 1/8- and 1/4-inch thick. Shim for rail fastener not having full bottom plate shall be 1/4 inch larger on all sides than rail fastener under which it will be placed. Holes shall be one inch diameter, and either punched or drilled to anchor bolt pattern.

C. Thread Sealant: Low melting point wax; Sanchem, Inc.'s NO-OX-ID 'A' Special, or accepted equivalent.

1.3 EXECUTION

A. Preparation: Test the Owner -selected anchorage inserts.
1. Pull-out test
a. Test equipment
1) Reaction plate: Steel plate with a hole drilled in center that is one inch larger than the insert top collar.
2) Loading system: As shown on accepted working drawings.

b. Test Procedures
   1) Restrained test: Place reaction plate over anchorage insert to be tested. Set-up accepted loading system and connect that system to bolt engaged in anchorage insert. Exert initial uplift of 1,000 pounds against reaction plate. Increase load against reaction plate at rate of 1,000 pounds per second until load becomes 20,000 pounds.
   2) Unrestrained test: Remove reaction plate and apply load of 10,000 pounds uplift on anchorage insert against reaction surface outside six-inch diameter area in which anchorage insert is centered.
c. Acceptance criteria: No evidence of anchorage moving upward.
d. Remedies: Anchorage insert failing to satisfy acceptance criteria will be rejected.
   1) Test every insert along that rail in both directions until 10 successive inserts in each direction satisfy the acceptance criteria.
   2) Remove defective anchorage insert and furnish and install new insert. Test new insert, and prepare a pullout test inspection report after that insert has been tested.

2. Torque test
   a. Procedure: Screw anchor bolt into anchorage insert tight against lock nut set two inches from end of bolt. Apply 500 foot-pounds to anchor bolt head.
   b. Acceptance criteria: Anchorage insert shall show no evidence of rotational movement.
   c. Remedies: Anchorage insert failing to satisfy acceptance criteria or not installed within the tolerances specified or both, will be rejected. Should an insert fail the torque test, test inserts in accordance with Article 1.4A.1.a.1).

B. Examination: Verify that the following conditions exist, and record data on Exhibits A, B, and C of this Section and of other Sections:
   1. Bearing surface of track concrete is within allowable tolerances for cant, elevation, and dimensions.
   2. Rail fastener anchorage inserts are undamaged, and have been installed perpendicular to and flush with top of concrete.
   3. Anchorage inserts have been subjected to restrained and unrestrained pull-out tests and torque tests, and defective inserts have been removed and replaced.

C. Installation
   1. Remove plugs from anchorage inserts and place rail fasteners with anchor bolts engaged in inserts. Coat threads of anchor bolts with thread sealant.
   2. Install shims between rail fastener and track concrete. Install not more than two shims at each rail fastener.
   3. Fully anchor rail fasteners to track concrete with anchor bolts torqued to 300 foot-pounds. Tighten anchor bolts on both sides of rail simultaneously. Check torquing equipment daily; torque of equipment shall be within two foot-pounds of that of calibrated and certified torque wrench specified in CONTINUOUS WELDED RAIL.

END OF SECTION 34 01 23 33c

SECTION 34 01 23 33d - CONCRETE TRACK CROSS TIES

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of ballast, precast concrete ties, rail fastenings, and continuous welded rail. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Submit certified test results of ballast tests not less than 15 days before starting shipment.

C. Quality Control
1. Source quality control: If ballast source or appearance change, test ballast gradation and visually inspect production site immediately before initially shipping first batch of ballast from that source and of that appearance.
2. Construction equipment: Subject to inspection and acceptance by the Owner.
   a. Ballast roller: Self-propelled, pneumatic-tired, and not lighter than nine tons.
   b. Ballast compactor: Vibratory, not lighter than 2-1/2 ton, and be capable of applying a dynamic load of nine tons. Ensure that control of compactor's tamping cycle will induce maximum uniform compaction.
   c. Ballast tamper: Production Type with a minimum of 16 squeeze-vibratory tamping shoes.

1.2 PRODUCTS

A. Materials
1. Sub-ballast (where required): Aggregate-soil materials conforming to an ASTM D 1241, Type I, Gradation A mixture. Use sub-ballast in frost areas where the ballast thickness requirement exceeds 10 inches and elsewhere as required.
2. Ballast: Crushed stone, Size No. 4 for mainline ballast materials and Size No. 5 for yard and house tracks, conforming to Chapter 1, Part 2, of American Railway Engineering Association (AREA) “Manual for Railway Engineering (Fixed Properties).”
3. Concrete Ties: Comply with the material requirements specified in Chapter 10 of AREA “Manual for Railway Engineering (Fixed Properties).” Concrete ties shall be a minimum of 8 ft. 6 in. in length.
4. Welded Rail: New rail shall be 115 lb. Section, **unless directed otherwise**, and shall conform to Chapter 4, Part 2 of AREA “Manual for Railway Engineering (Fixed Properties).” Relay rail shall conform to criteria specified in Chapter 4, Part 2 of AREA “Manual for Railway Engineering (Fixed Properties).” Mingling of new and relay rail will not be permitted.

1.3 EXECUTION

A. Installation
1. Initial ballast
   a. Uniformly distribute ballast over the sub-ballast and firmly compact before distributing ties.
   b. Uniformly spread each lift of ballast within initial layer with not less than four passes of either a roller or compactor. Limit the depth of each compacted lift within the initial layer to four inches. Make top of initial layer not less than four inches below final ballast surface.
2. Ties: Place primary track ties on 30-inch centers. Place secondary track ties on 33-inch centers.

a. Place ties to ensure that bottom of each tie will bear fully on initial layer of ballast and be normal to track centerline.
b. Arrange ends of ties containing contact rail bracket anchor inserts to be on contact rail side.

3. Continuous Welded Rail (CWR)
   a. Remove ballast and debris from inserts and concrete ties before placing rail pads, CWR, and rail clips.
   b. Place CWR on the pads in accordance with accepted working drawings. Do not drag CWR over rail pads. Use no on-track equipment until CWR has been fastened to concrete ties.
   c. Install, anchor and field-weld CWR producing zero thermal stress in rail at 85 degrees F, plus five degrees F, or minus 10 degrees F. Anchor opposite rails at temperatures within five degrees F of each other.
   d. Anchor rails in ballasted track by installing rail clips and fastener insulators in accordance with concrete tie manufacturer's recommendations. Proceed with final rail anchoring in ballasted track only after track has been ballasted preventing tie movements caused by thermally induced force and until track has been initially raised, tamped, and aligned.

B. Surfacing And Aligning: Place ballast in cribs and shoulders of track structures, and in quantities which will fill tie cribs and be sufficient for initial track raise and to hold track after initial track raise.
   1. Surface track without bending rail, straining joints, or damaging rail fastenings. Simultaneously tamp ballast on both sides of tie, from points 15 inches inside both rail centers to ends of tie. Limit each track lift to not more than four inches. Initially raise track to an elevation ensuring that a final raise of neither less than one inch nor more than three inches will be required to bring track to final elevation.
   2. After track has been initially raised and aligned, field-weld and anchor rails within specified zero thermal stress range. Remove damaged ties and fastenings, in the judgment of the Owner, during surfacing operation and install new ties and clips. Suspend surfacing when ambient temperature is hotter than 95 degrees F.
   3. Compact shoulders and cribs with a vibrator compactor acceptable to the Owner. At no additional expense to the Owner, remove at random a maximum of one percent of ties so that the Owner may inspect compaction of ballast beneath ties to determine tamping variables of each piece of tamping equipment, and to spot-check production work. Reinstall ties immediately after compacted ballast has been accepted.
   4. Complete final surfacing and aligning of track. Reslope fouled and disturbed subballast outside toe of ballast slope.

END OF SECTION 34 01 23 33d

SECTION 34 01 23 33e - TIMBER TRACK CROSS TIES

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of products for hi-rail accesses, timber panels, and grade crossings. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Ties: Timber type; 8-1/2 feet long except ties on which contact rail insulators will be mounted shall be ten feet long. Furnish ties which will be within limits of panels, and ties which will be not more than 10 feet beyond panels.

B. Panel Timbers, Flangeway Timbers, And Support Blocks: American Railway Engineering Association (AREA) “Manual for Railway Engineering,” Chapter 3, Part 6, Type A, fine-grained hardwood such as maple, gum, or birch and specially fabricated as indicated. Support blocks shall be fabricated from a single piece of timber.

C. Hi-Rail Access: Panel timbers, flangeway timbers, and support blocks.

D. Drive Dowels: Steel conforming to ASTM A 575, twisted, of diameter not smaller than 3/4 inch.

E. Drive Spikes: Dome head steel type, 3/4-inch diameter by 12-inches long, and galvanized in accordance with ASTM A 153; Lewis Bolt and Nut Co., or accepted equivalent.

F. Guard Posts: Galvanized steel pipe conforming to ASTM A 53, Grade B, 4-inch diameter by 8-feet long.

G. Ballast Prime Coat: Grade MC-250.

H. Asphalt Concrete: Asphaltic Concrete in accordance with the requirements of YYYY57YYYY.

I. Concrete: Class 3000 Portland Cement Concrete, in accordance with requirements of YYYY73YYYY.

J. Timber Screws For Anchoring Rail Fasteners

K. Rail Fasteners: L. B. Foster Co.'s, Transit Products Division, "Type H-10", or approved equivalent.

L. Tie Plates:

M. Track Spikes:

N. Guard Rails: Guard Rail, conforming to the requirements of YYYY616YYYY.

O. Ballast: Conforming to the requirements of YYYY602YYYY.

P. Aggregate Base: Aggregate.

Q. Fabrication: Fabricate timbers and blocks before pressure-treating.
1. Fabricate timbers to be eight feet long.

a. Orient timber heartwood to be downward.
b. Cut ends of timbers square except bevel distal ends of timbers, which will comprise the end panels, at 45 degrees.
c. Cut timbers to dimension ensuring that top of installed panel is 3/4 inch below top of rail.
d. Notch flangeway timbers to clear rail fastener and tie plate hardware by not less than 1/2 inch.
e. Drill 5/8 inch diameter holes for drive spikes through timbers, and on 19 3/16-inch centers. Arrange adjacent holes to be on opposite sides of tie centerline.
f. In hi-rail access timber panels, drill four, 5/8 inch diameter holes for drive dowels; drill parallel to center of timbers' vertical dimension. Holes shall be no closer to end of timbers than one foot, and remainder equidistant from each other.

2. Fabricate blocks to fit between rail fasteners and tie plates, and such that blocks will support notched portion of flangeway timbers.
3. Pressure-treat timbers and blocks in accordance with AREA Chapter 3, Part 6.
4. Assemble treated timbers into panels eight feet long, with heartwood downward and ends aligned with each other. Drive dowels.

1.3 EXECUTION

A. Examination: In accordance with requirements of YYYY602YYYY.

B. Preparation: In accordance with requirements of YYYY602YYYY.

C. Installation:
1. Place initial layer of ballast.
2. Distribute and place timber ties on 19-3/16-inch centers, with wider heartwood downward, normal to centerline of track, and aligned with ends of ties on line side of track equal distance from rail.
3. Place aggregate base.
4. Place and anchor rail fasteners and tie plates to timber ties with timber screws and track lock spikes
5. Unload, lay, and join CWR; clip and spike CWR to rail fasteners and tie plates, and raise, align, and surface track to indicated lines, grades, and elevations.
6. Dress ballast level one inch below top of ties and to slopes indicated.
7. Drill 1/2 inch diameter holes into installed ties for drive spikes for a depth of five inches, immediately remove debris from holes, and fill holes with pentachlorophenol. Panels may be installed to facilitate the temporary access by hi-rail equipment, but shall be removed for grinding of the running rail.
8. Place one-piece support blocks in space between ties and flangeway timbers, against base of rail, and between rail fasteners. Place panels on ties and support blocks, and arrange panels with ends coinciding with centers between the ties; butt ends of panels. Dap and saw flangeway timbers, panel timbers, and support blocks to satisfy field conditions within specified tolerances, and apply pentachlorophenol to dapped and sawed timbers and blocks. Insert no shims between panels and ties.
9. Drive spikes vertically, and until spike head bears on timbers.
10. Apply prime coat and asphalt concrete in accordance with the requirements of YYYY57YYYY.
11. Apply asphaltic concrete between flangeway timbers and grade crossings in accordance with the requirements of YYYY57YYYY.
12. Install crossing in accordance with crossing manufacturer's printed installation instructions.
13. Install guard posts vertically and project posts three feet above top of rail; fill posts with concrete and crown top in accordance with the requirements of YYYY73YYYY.
14. Install guard rail in accordance with the requirements of YYYY616YYYY.
15. Tolerances from design dimensions.
a. Top of flangeway timber, vertical depression below top of rail: Plus 1/4 inch, minus zero.
b. Clearance between side of flangeway timbers and edge of rail: Plus 1/2 inch, minus zero.

c. Difference in elevation between surface of flangeway timber and surface of abutting asphalt concrete: 1/4 inch.

END OF SECTION 34 01 23 33e

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SECTION 34 01 23 33f - RESILIENT TRACK CROSS TIES

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of resiliently supported track at-grade, and continuous welded rail. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control:
1. Testing of Resiliently Supported Two-Block Concrete Tie Assembly: In lieu of qualification testing of two-block concrete tie complete with resilient supports and rail fastening assemblies in accordance with Flexural Strength Testing of two-block ties in AREA MRE Chapter 10, Section 1.10 and tests for Noise and Vibration Performance as specified in this Section, Contractor may submit for the Owner approval certification by an independent testing laboratory that ties, supports, and rail fastenings have passed the tests specified or equivalent tests.
   a. Submit for the Owner approval, prior to fabrication and testing, shop drawings detailing two-block concrete ties, resilient supports, and rail fastenings; detailed description of steps required for complete installation, replacement and adjustment of individual components; and detailed description of all tests.
   b. Arrange testing to be performed by an independent testing agency approved by the Owner. Production testing may be performed at Contractor's facility providing that facilities and testing procedures meet the approval of the Owner.
   c. All testing performed by Contractor shall be witnessed by the Owner.
   d. Qualification tests for Noise and Vibration Performance.
      1) Test assembly
         a) Except as otherwise specified herein, perform tests on a single concrete tie block complete with resilient supports, and rail fastening assembly certified to be identical to those to be furnished. Single concrete tie block shall be cut from a complete two-block tie assembly by cutting in half the tie bar joining the tie blocks.
         b) Cast or grout two-block tie and single tie block complete with resilient supports in a Class 4000 concrete foundation block as specified.
         c) Assemble a section of 115 RE rail not shorter than one foot, rail pad, and rail fastenings to two-block tie. Torque or drive rail fastenings in same manner and with the same force or torque as specified.
         d) Immediately prior to starting tests, stabilize temperature of all components of the assembly at 68 degrees F, plus or minus four degrees F.
         e) Perform testing only when ambient temperature is 68 degrees F, plus or minus four degrees F unless otherwise specified.
      2) Sequence of tests on assembled resiliently supported two-block concrete tie.
         a) Static vertical stiffness test
            i. Vertical test load: Zero to 15,000 pounds, applied at a steady rate of 2,000 pounds per minute with optional 30-second pauses at every 1,000-pound increment.
            ii. Point of application: Downward at and normal to centerline of rail and centerline of tie block.
         b) Test procedure
            i. Preconditioning and seating loading: Apply vertical load varying at a rate of 2,000 pounds per minute from zero to 15,000 pounds and back to zero load. Set the deflection reading devices at zero one minute after load returns to zero pounds.

ii. For each 1,000-pound load increment, measure and record vertical deflection of the rail head to the nearest 0.001 inch 30 seconds after rail head has stopped moving.

iii. Upon completing measuring and recording vertical deflection of the rail lead at 15,000 pounds nominal load, commence reducing the load at the same rate that was used for loading and record vertical deflections of the rail at 1,000-pound load reduction increments. One minute after reaching zero load on rail, measure and record the residual deflection of the rail.

iv. Average the two sets of vertical deflection readings for determining the normal deflections of the rail. Plot the normal deflections against the record values for vertical loads.

v. Calculate the vertical static stiffness of the resiliently supported two-block assembly by dividing the measured difference in static force between nominal values of 7,000 and 8,000 pounds by the measured difference in the average static deflection at 7,000 and 8,000 pounds.

c) Test acceptance criteria

i. Slope of the load-deflection curve: Not less than 50,000 pounds per inch nor more than 90,000 pounds per inch for all loads between 5,000 pounds and 15,000 pounds. Constancy of slope: Within 10 percent over the load range.

ii. Recovery of tie block to original rail-head position: Within 0.015 inch of its pre-test position within one minute after test load has been removed.

3) Dynamic vertical stiffness test

a) Vertical test load: Sinusoidal force with a zero-to-peak amplitude of 500 pounds and a frequency of six Hertz, superimposed on a static compressive force of 7,500 pounds.

b) Point of application: Downward at and normal to centerline of rail and centerline of tie block.

c) Points on rail for measuring deflections: Two along centerline of rail and equidistant from point of load application.

d) Measurement technique: Measure vertical force with a device capable of long term DC response to force, such as a strain gauge load cell. Measure vertical deflection with two identical linear variable differential transformer (LVDT) displacement gauges located symmetrically about the line of vertical force application. Locate displacement transducers above or below rail. Indicate DC force with a device capable of DC response without interference from the dynamic force component, such as an oscilloscope, oscillograph, or meter with long averaging time. Indicate the dynamic force and displacement with a device capable of detecting a six Hertz signal, but not responding to or compensating for DC signals, such as an oscilloscope, oscillograph or low frequency AC coupler meter.

e) Test procedure

i. Apply a constant vertical compressive force of 7,500 pounds to the top of the rail, centered over the rail and the centerline of the single tie block. After the constant force has been established, superimpose on it a sinusoidally varying six Hertz force with a zero-to-peak amplitude of 500 pounds.

ii. Observe and document the DC and AC components of the force and the AC component of the deflection to an accuracy of plus or minus three percent.

iii. Calculate the dynamic stiffness of the single tie block at a static compressive force of 7,500 pounds by dividing the measured peak-to-peak force by the measured peak-to-peak deflection.

f) Test acceptance criteria: Dynamic vertical stiffness shall be not less than 300,000 pounds per inch nor more than 500,000 pounds per inch.

4) Static lateral stiffness test
   a) Vertical preload: Apply a constant force of 7,500 pounds through the centerline of rail and centerline of tie block with a fixture not restraining or causing lateral motion of the tie block or imposing lateral forces in excess of two percent of the maximum lateral test force.
   b) Lateral test load: Zero to 7,500 pounds, applied at a steady rate of 1,000 pounds per minute with optional 30-second pauses at each 500-pound increment. One complete test cycle shall be run using a compressive load on the tie bar, and one complete test cycle shall be run with a tensile load on the tie bar.
   c) Point of application: Apply lateral test loads to the projecting end of the cut tie bar, with the line of action of the force along the centroid of the lower horizontal leg of the tie bar. Rollers or large radius linkages may be used to restrain motion of the tie bar caused by the eccentricity of the line of action of the force with the area of the boot resisting the lateral force. However, the means of restraint must not interfere with the deflection of the tie block under the vertical preload or the lateral deflection of the block.
   d) Points on tie block for measuring deflections: Measure deflection of tie block at a point on the end of tie block opposite tie bar, one inch above top of boot in the unloaded position, and on centerline of tie block.
   e) Test procedure
      i. Apply 7,500-pound vertical preload downward through center of rail at the centerline of tie block. Adjust linkages or rollers to prevent excessive motion of the tie bar normal to the line of action of the lateral force.
      ii. To precondition and seat tie and boot assembly, apply a lateral load varying from zero to 7,500 pounds and immediately return to zero at a rate of 1,000 pounds per minute. Zero lateral deflection reading devices one minute after the lateral load returns to zero pounds and immediately commence test.
      iii. Apply lateral load to the tie bar at a constant rate of 1,000 pounds per minute. If non-recording instrumentation requires pauses in loading to read instruments, stop loading at each 500-pound increment, read instruments 30 seconds after stopping loading and immediately resume loading.
      iv. Upon reading the load and deflection of the rail at 7,500 pounds lateral load, reduce lateral load to zero, then reduce vertical preload to zero.
      v. If data was manually read, record data points on a graph of lateral deflection as a function of load.
      vi. Calculate lateral static stiffness of the single tie block, boot and pad assembly by dividing the measured difference in static force between nominal values of 3,000 and 4,000 pounds by the measured difference in static deflection at 3,000 and 4,000 pounds.
      vii. The nominal static lateral stiffness of a complete resiliently supported tie assembly is equal to the sum of stiffnesses measured under compression and tension of the tie bar.
   f) Test acceptance criteria
      i. Lateral stiffness with lateral load applied from gauge side: 120,000 to 170,000 pounds per inch.
      ii. Lateral stiffness with lateral load applied from field side: 165,000 to 170,000 pounds per inch.

5) Water absorption of tie pad test:
   a) Test procedure: ASTM D 1056

i. Cut two 29 mm diameter samples of the pad used between the bottom of the tie and the elastomer boot from two different pads and weigh them to an accuracy of plus or minus one percent. This weight is designated as P0 for each pad in the following formula.

ii. Immerse the samples in distilled water at room temperature, and hold them 50 mm below the surface with a wire probe or cage.

iii. Decrease the pressure in the atmosphere above the water to 635 mm of mercury.

iv. After three minutes at the reduced pressure, return the pressure above the water to ambient atmospheric pressure.

v. After three minutes at ambient atmospheric pressure, remove samples from water, superficially dry surfaces by gentle blotting without squeezing samples and weigh them to an accuracy of plus or minus one percent. This weight is designated as P1 for each pad in the following formula.

vi. Calculate the percentage change in weight of each sample using the formula:

$$A = 100(P1 - P0)/P0 \text{ percent}$$

b) Test acceptance criteria

i. Weight change due to water absorption: not more than 0.10 grams

ii. Volume change due to water absorption: not more than 0.10 grams

6) High voltage withstand test: effect of high voltage on quality of tie pad material.

a) Test Procedure: Place a metal ground plate between concrete test block and tie pad. Apply a DC potential of 15KV between rail-head and ground plate for one minute.

b) Test acceptance criteria: Neither cracks, pin-holes or electric flash over or arcing nor fracture to occur.

7) Electrical resistance and impedance test

a) Dry resistance:

i. Remove moisture, if any, from concrete tie block assembly and with one lead of high potential tester connected to rail head and ground lead connected to rail fastening system, apply 500 volts DC for three minutes. Use the current value obtained to calculate resistance.

ii. Acceptable resistance to 500 volts DC: not less than 10 megohms.

b) Wet resistance:

i. Release ground plate, tie pad, and rail fastening system from concrete tie block and rail; immerse tie pad in distilled water for six hours at 100 degrees C for neoprene based elastomers and for 336 hours at 70 degrees C for natural rubber based elastomers.

ii. After tie pad has been removed from water without drying and with no portion of the concrete tie block assembly cooler than 35 degrees C., reassemble ground plate, tie pad, rail fastening system, and rail on the tie block and test for electrical resistance as follows:

With one lead of high potential tester connected to rail head and the other lead ground to rail fastening system, apply 500 volts DC for three minutes, and test for electrical resistance. Use current value obtained to calculate resistance.

Allowable resistance: Not less than one megohm.

c) Wet impedance:

i. With the rail tie pad and rail fastening system still wet and with no portion of the concrete tie block assembly cooler than 35 degrees C, apply a potential of 50 volts AC between rail head and grounded rail fastening system until reading has stabilized for 30 seconds of

measurement for frequencies 1,000, 2,000, 4,000, 6,000, 8,000, and 10,000 Hertz.

ii. After reading has stabilized for 30 seconds, measure impedance of each frequency within an accuracy of plus or minus two percent and record each frequency.

iii. Impedance for frequencies between 20 Hz and 5 kHz with 50 volts AC shall be 10,000 ohms, at 6 kHz shall be 9,000 ohms, at 8 kHz shall be 7,000 ohms, and at 10 kHz shall be 6,000 ohms.

2. Construct a complete demonstration section of resiliently supported track not shorter than 50 track feet; construct within trackway and where required by the Owner. Section constructed to specified tolerances will become a part of the permanent track; otherwise, remove section and construct another section until constructed as indicated.

1.2 PRODUCTS

A. Ties: Concrete and steel two-block type; either Nucor Corp.'s Nucor-VSB or Stedef Inc.'s Stedef-VSB, or accepted equivalent.

B. Rail-Fastening System: Either Nucor Corp.'s S75 Fastenings, Stedef Inc.'s A. P. Fastening System, or accepted equivalent.

C. Resilient Support
1. Tie Boot And Pad: Conform to either Nucor Corp.'s S75, Stedef Inc.'s Technical Specification No. S120-4, or accepted equivalent.
a. Rubber boot with microcellular pad.
b. Tie pad: closed-cell cellular neoprene or elastomer.
c. Boot restraints: Either a rigid support that will engage lip of boot on both sides of the rail or a series of rubber bands or plastic strapping of size and strength which will restrain applied boot against sides and bottom of tie without noticeable sag and without compressing tie pad.
2. Rail Pad: Rubber; nine millimeters thick; have longitudinal grooves; conform to either Nucor Corp.'s S75; International Union of Railways' Technical Specifications 864-5-0, Stedef Inc.'s Technical Specifications No. S120-OB; or accepted equivalent.

D. Concrete Reinforcement: CONCRETE REINFORCEMENT.

E. Concrete Formwork: CONCRETE FORMWORK.

F. Concrete: Class 4000 Portland Cement Concrete.

G. Superelevation Tags: Brass or anodized aluminum; 1-1/4 inches wide by two inches long by 0.050 inch thick; and stamped with numerals 3/4 inch high, except that numerals for fractions shall be 3/8 inch high.

1.3 EXECUTION

A. Preparation: Establish track offset reference line, and chisel reference line mark on slab at intervals of not more than 20 feet. Along curved sections of track, chisel offset reference line mark at intervals to ensure that distance between chord drawn between two marks and indicated curve reference line will be not more than 0.005 foot.

B. Installation
1. Space two-block ties perpendicular to track centerline, and on 30-inch centers, plus or minus one inch except at insulated joints. Place two-block ties at insulated joints as indicated within plus or minus 1/2 inch.

2. Place rail pads between shoulders on concrete ties.
3. Place rail on rail pads; do not disturb ties when connecting rails and fastening rail to ties. Torque or drive rail fastenings in accordance with manufacturer's printed instructions.
4. Raise track, and support and block track to its final line and grade. Secure to hold track at final line and grade during concrete placement. Support assemblage only from base of rail. Conform track to required position.
    a. Completely brace and support track section to be concreted at one time. Support track for not less than 100 feet beyond that track section being concreted, to ensure that track section will not be stressed.
    b. Install reinforcement in accordance with CONCRETE REINFORCEMENT.
    c. Install formwork in accordance with CONCRETE FORMWORK.
    d. Immediately before installing boot and tie pad, ensure that no water is in boot. Apply boot restraints to each tie without scratching and tearing boot and pad; ensure that boot and tie pad fit flush against sides and bottom of tie.
    e. Ensure that ties are normal to centerline of track. If tie needs to be adjusted to be perpendicular to track centerline, loosen rail-fastening system, align tie, and retighten or redrive rail-fastening system.
    f. Before placing concrete, survey and verify final line and grade on raised and supported track comply with established controls.
    g. Place concrete in accordance with CAST-IN-PLACE CONCRETE.
    h. Ensure that there is no concrete spillage on ties, lip of boots, rail fastenings, and inside boot.
5. After concrete has been placed for not less than four hours, loosen rail fastenings to prevent thermal stresses in rail.
6. Remove track supports and formwork and cleanout drainage chases and blockouts.

C. Jointing And Anchoring Rail: CONTINUOUS WELDED RAIL.

D. Installing Superelevation Tags: Install tags on concrete ties one foot inside superelevated CWR, and orient tag to be read in ascending order from tangent to spiral, through spiral to curve.
1. Wire brush attachment surfaces and remove all loose material from concrete surfaces.
2. Wire brush back side of tags, apply epoxy to tags, and press tags onto concrete ties at beginning and ending points of curved track and at elevation increments of 1/4 inch within spirals.

E. Final Alignment And Track Inspection: CONTINUOUS WELDED RAIL.

END OF SECTION 34 01 23 33f

SECTION 34 01 23 33g - TRACK APPURTENANCES AND ACCESSORIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of buffers. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control
1. Field quality control
a. Before installing insulated joints, have each joint installing crew prepare two samples of that joint.
b. Have an independent testing laboratory test each insulated joint sample for resistance to longitudinal pull-apart.
c. Record and certify that rail has been re-anchored within the zero stress temperature range.
2. Testing: In lieu of qualification testing of insulated joints, Contractor may submit certification by an independent testing laboratory that insulated joints have passed either the tests specified in this Article or equivalent tests. Test two samples for resistance to longitudinal pull apart, and test one sample for electrical resistance.
a. Longitudinal pull apart test
1) Preparation
a) Assemble bonded insulated joint complete, on two pieces of 115-pound RE rail each two feet long.
b) Saw joint assembly in half where rails are butted together and at right angles to centroid of rail.
c) Ensure that sawing does not overheat and damage prebonding adhesive.
d) Affix a device which will confine the reaction at the sawn end to the face of the joint bar when a load is applied at the centroid of the rail at the opposite end.
2) Testing
a) Apply test longitudinally in increments of 25,000 pounds maintaining each increment until longitudinal deflection of rail ceases before increasing load to next increment.
b) Increase load in increments until a total load of 650,000 pounds is attained or failure occurs.
c) At each increment of loading, measure and record load, and differential movement of rail and joint bars, to nearest 0.001 inch.
3) Acceptance criteria
a) Stability: No indication of slippage of rail joint before total test load reaches 650,000 pounds.
b) Differential movement in all directions: not more than 1/8 inch.
c) Difference between original position of joint bar and rail and final position thereof after final test load has been released: not more than 1/32 inch.
d) Basis of rejection: Failure of joint to satisfy above requirements.
b. Stroke rolling loading test
1) Preparation: Mount bonded joint on a 33-inch stroke rolling load test machine and support on 36-inch centers; center joint.
2) Testing: Apply 44,400 pound load on rail for 2,000,000 cycles. Measure and record deflection at rail centerline to nearest 0.001 inch when wheel load is over points A and B for every 500,000 cycles.
3) Develop moment diagram.
4) Acceptance criteria

a) Moment diagram envelope generated by methods other than those specified and submitted in accordance with this Section.
b) After 2,000,000 cycles: Exhibit no evidence of failure by bending of bonded insulated joint.
c) Deflection exhibited by bonded insulated joint: Not further than 0.065 inch.

c. Electrical resistance test: If specimen satisfies mechanical acceptance criteria of preceding tests, test specimen for electrical resistance; record results.
1) Preparation: Assemble bonded insulated joint complete, in accordance with manufacturer's instructions, on two pieces of 115 pound RE rail, one rail 24 inches long, the other 42 inches long. Support both rails on electrically nonconductive material.
2) Testing
a) Apply 500 volts DC to rail across bonded insulated joint for three minutes. During that time, measure and record, to nearest 0.1 ampere, current flow through joint.
b) Apply 50 volts AC to rail across joint for three minutes for each increment of measurement at frequencies of 20 hertz to 10 kilohertz in increments of 20 hertz to 100 hertz, 200 hertz to 1,000 hertz, and two kilohertz to 10 kilohertz. After three minutes, measure and record impedance within accuracy of plus or minus two percent.
3) Acceptance criteria
a) Resistance for 500 volts DC: Not less than 10 megohms.
b) Impedance for all frequencies between 20 hertz and 10 kilohertz with 50 volts AC not less than 10 megohms.

1.2 PRODUCTS

A. Insulated Joint
1. Joint bar: 36 inches long; quenched and tempered carbon steel; fabricated in accordance with AREA MRE Chapter 4, Part 1, Table 1, for 115-pound RE rail; have six, 1-1/4-inch diameter holes spaced in accordance with AREA MRE Chapter 4, Part 1, Table 1; have a length tolerance of 1/8 inch; have a straightness tolerance of 1/32 inch on 36 inches along contact surface; and have no marking on contact surface. Modify bar for rail restrained by direct-fixation fasteners.
2. Adhesive: Allegheny Drop Forge Co.'s "Temprange" or accepted equivalent.
3. Mesh: Fiberglass; Allegheny Drop Forge Co., or accepted equivalent.
4. Pin bolts and insulation for bonded insulated joint
a. Bolt: 9-1/8-inch by 1-1/8-inch diameter pin-type; ASTM A 325; Huck Corp's C50LR-BR-36-68, or accepted equivalent.
b. Washer: ASTM A 325, flat, 2-1/4 inches O.D. by 1-3/16 inches I.D. by 1/8 inch thick.
c. Collar: 1-1/8-inch diameter; ASTM A 325; Huck Corp.'s LC- 2R36, or accepted equivalent.
d. Bushing: Fiberglass conforming to NEMA LI-1, Grade G10.
e. Post: High-pressure laminate conforming to NEMA LI-1, Grade CE.
5. Pin-bolts for unbonded insulated joints
a. Bolt: ASTM A 490, 1-1/8-inch diameter, hex head type, six inches long.
b. Washer: ASTM A 325, spring steel, 1/8 inch thick, 2-1/4-inch O.D.
c. Nut: ASTM A 490, hex head locknut.

B. Buffer: Friction type having head modified for the Owner anti-climber; Godwin Warren Engineering Inc.'s Type 12/4, or accepted equivalent.
1. Type A: Capable of controlling the stopping of an eight-car train under the following conditions:
a. Impact force: Not more than 130,000 pounds;
b. Impact speed: 15 mph;
c. Weight per car: 81,000 pounds;
d. Rotational inertial weight per car: 7,800 pounds; and

e. 98 feet of track available for buffer installation.

2. Type B: Capable of controlling the stopping of a two-car train in the yard when that train, decelerating at a rate of not more than 0.3 g's, strikes the buffer at 15 mph; and capable of controlling the stopping of a four-car train under the following conditions:
   a. Impact force: Not more than 130,000 pounds;
   b. Impact speed: 15 mph;
   c. Weight per car: 81,000 pounds;
   d. Rotational inertial weight per car: 7,800 pounds; and
   e. 38 feet of track available for buffer installation.
3. Paint for structural steel surfaces not facing transit vehicle
   a. Primer: Either Pratt and Lambert Co.'s Rust-Inhibiting Effecto Enamel, PPG Corp.'s No. 6-208, Porter Paint Co.'s No. 297, Sherwin-Williams Co.'s Kem Kromik, or Tnemec Co.'s No. 10-99, or accepted equivalent.
   b. Enamel: Color international orange; either Pratt and Lambert Co.'s Effecto Enamel, PPG Corp.'s No. 6-252, Porter Paint Co.'s No. 400, Sherwin-Williams Co.'s Industrial Enamel B54 Series, or Tnemec Co.'s Series 2H, or accepted equivalent.
4. Paint for structural steel surfaces facing transit vehicle: Reflective type; Ferro Corp., Cataphote Division's Alert- Reflective Yellow, 3M Co.'s Scotchlite Brand Reflective Liquid, or accepted equivalent.

C. Bumper: Capable of controlling the stopping of a two-car train under the following conditions.
1. Impact force: Not more than 150,000 pounds.
2. Impact speed: 10 mph
3. Weight per car: 81,000 pounds.
4. Rotational inertial weight per car: 7,800 pounds.
5. Striking block
   a. Adapter plate: Mild steel.
   b. Rubber block: 70 to 80 shore hardness, and adhered to adapter plate.
6. Shock absorber: Hydraulic type having 31-1/2-inch stroke; Gantrex Corp.'s Type 15 Oleo, or accepted equivalent.
7. Post
   a. Structural steel plates, shapes, and bars: Carbon steel; ASTM A36.
   b. Welding electrodes: AWS D1.1; E70XX.
   c. Anchor bolts: 5/8 inch and 3/4 inch diameter; ASTM A 325.
   d. Concrete forms: CONCRETE FORMWORK
   e. Concrete: PORTLAND CEMENT CONCRETE.
   f. Reinforcing bars: CONCRETE REINFORCEMENT.
8. Paint
   a. Primer: Either Pratt and Lambert Co.'s Rust-Inhibiting Effecto Enamel, PPG Corp.'s No. 6-208, Porter Paint Co.'s No. 297, Sherwin-Williams Co.'s Kem Kromik, or Tnemec Co.'s No. 10-99, or accepted equivalent.
   b. Enamel: Color international orange; either Pratt and Lambert Co.'s Effecto Enamel, PPG Corp.'s No. 6-252, Porter Paint Co.'s No. 400, Sherwin-Williams Co.'s Industrial Enamel B54 Series, or Tnemec Co.'s Series 2H, or accepted equivalent.

D. Rail Lubricator: Moore and Steele Corp.'s Model No. DR-4 (561), or accepted equivalent.

E. Car Stop: L. B. Foster Co.'s Figure X, or accepted equivalent.

1.3 EXECUTION

A. Insulated Joints
1. Preparation: If rail brand exists where joint bar will touch CWR, remove rail brand. Calibrate bolt-tightening and -swaging tool by testing three typical bolts in a device capable of indicating actual bolt tension.

2. Installation
   a. Drilling: Position holes in accordance with AREA MRE Chapter 4, Part 1, Table 1. Drill 1-3/8-inch diameter holes; use template as a drilling guide.
   b. Install joint bar, adhesive, fasteners, and insulating materials in accordance with manufacturer's printed recommendations except install no adhesive at joints at Stations.
      1) Bonded insulated joint: Drive pin bolts with tool capable of swaging collars to the extent that bolts may be adjusted. Set tool to produce not less than 56,000 pounds tension in pin bolts, to swage collars into annular locking grooves, to form collar, and to ensure that bolts will conform to grip range limits recommended by bolt manufacturer.
      2) Unbonded insulated joint: Tighten each track bolt to 25,000 pounds, starting from middle of joint and working to the ends.
   c. Ensure that joint products and rail fasteners do not touch each other.
   d. Center insulated joints not less than five inches from edge of tie and rail fastener.
   e. Attach grounding cable, to base of each CWR, immediately adjacent to joint at Stations.
   f. Tolerances from design dimensions.
      1) Bonded insulated joint bar
         a) Finishing height: 1/64 inch.
         b) Length: 1/8 inch.
         c) Straightness, as determined by use of a 36-inch straightedge: 1/32 inch.
      2) Bonded insulated joint end post
         a) Thickness: Plus 1/16 inch, minus zero inch.
         b) Projection below base of rail: 1/16 inch
3. Joint bolt hole: AREA MRE, Chapter 4.
   a. Testing: Measure continuity across joint.
4. Remove clamps, flexible ground cables, fasteners, and joint bars from joints at Stations; deliver those products to the Owner 's Yard.

B. Buffers: Install buffers in accordance with manufacturer's printed instructions, and with four sets of trailing shoes set at a torque of 100-foot pounds, except that friction buffer at Station shall be installed with two sets of trailing shoes set at a torque of 150-foot pounds. Installed buffers shall be inspected by manufacturer's representative and, if approved by that representative, commissioned by that representative.
   1. Dismantle buffer at Stations , and temporarily install buffer at Station .
   2. Install new buffers at Stations .
   3. Install friction buffer at Station .
   4. Cleaning and painting
      a. Clean surfaces to be painted; wash surfaces with mineral spirits, and dry. Open drain holes in structural framework. Wire brush or blast unpainted ferrous surfaces to white metal.
      b. Apply paint with clean and operable equipment and tools as soon as practicable after surfaces have been prepared; wet film shall cure to specified dry film thickness.

C. Bumper
   1. Weld in accordance with AWS D1.1.
   2. Form concrete in accordance with CONCRETE FORMWORK. Place concrete reinforcement and concrete in accordance with CONCRETE REINFORCEMENT, and CAST-IN-PLACE CONCRETE, respectively. Finish exposed concrete in accordance with UNFORMED-CONCRETE FINISHES.
   3. Cleaning and painting: Clean and paint posts and framework as specified.

D. Rail Lubricator: Install lubricator in accordance with manufacturer's printed instructions.

E. Car Stops: Install stops in accordance with stop manufacturer's printed installation instructions. Install one stop three feet from end of shorter rail behind each buffer, and install one stop directly opposite that stop.

END OF SECTION 34 01 23 33g

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SECTION 34 01 23 33h - TRACTION POWER

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of products for bonding joints in running rail. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control: Construction Equipment
1. Rail grinder: Have vitrified grinding wheel.
2. Rail cleaner: Nontoxic, and capable of removing grease, rust, scale, and dirt.

1.2 PRODUCTS

A. Cable For Pin-Type Bond: Consist of 500 MCM, 259 strands, single conductor, insulated, nonshielded cable specified in Division 34 Section “Contact Rail System".

B. Cable For Welded-Type Bond: Bare, annealed copper 250 MCM, single conductor, and stranding conforming to ASTM B 173 Class G, and have swaged steel sleeve or ferrule type welding lugs designed to enable cable ends to be exothermically welded to running rails; ERICO Products Inc.'s Part No. PBC1-2W-13, or accepted equivalent.

C. Pin-Type Traction Power Bond: Fit 500 MCM cable and one inch diameter hole in rail; Erico Products, Inc.'s No. B-188-3Q slotted rail terminal having pin, washer, and lock nut, or accepted equivalent.

D. Protective Coating: Dearborn Chemicals Co.'s NO-OX-ID, or accepted equivalent.

1.3 EXECUTION

A. Preparation: Grind bonding surfaces of rail; and remove scale, rust, grease, and dirt.

B. Pin-Type Bond
1. Position bond further than six inches from a joint bar, further than 18 inches from center of a welded joint, and further than six inches from each other.
2. Drill one inch diameter hole at the neutral axis of the rail, perpendicular to the vertical and longitudinal axis of the rail, but not through rail brand. Holes shall be bright, clean, dry, and free from rust, burrs, and foreign substances affecting conductivity of joint and soundness of rail.
3. Drive a lubricated tapered punch, of a size recommended by bond manufacturer, through slotted rail terminal; then insert a correctly-sized drift pin. Install washer and torque lock nut in accordance with nut manufacturer's printed recommendation.
4. Connect cable to terminal by either compression method or exothermically welding; connect in accordance with connection manufacturer's printed recommendations.
5. Peen installed bonds.
6. Place cables along bottom flange of running rails and secure cables to flange with cable clips.

C. Welded-Type Bond
1. Position bond on field side of rail heads around bolted joints.
2. Exothermically weld bond in accordance with weld manufacturer's printed instructions, ensuring that weld will be mechanically and electrically continuous.

3. Apply protective coating to rail head bond in accordance with coating manufacturer's printed instructions.

D. Field Testing: Test welded bond by hammer and striker test, and in accordance with welding kit manufacturer's printed instructions. If bond is defective, remove bond, furnish and install new products for bonding joints, and test new bond.

END OF SECTION 34 01 23 33h

SECTION 34 01 23 33i - ROADWAY CROSSING CONTROL EQUIPMENT

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of products for crosswalk and grade crossing. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Crosswalk
1. Timber: Number 2 pressure-treated yellow pine. Stamp each timber AWPI DRY and AWPI LP-2 before treating timber. Reduce moisture content of decking and decking support members to not more than 19 percent by weight by kiln drying before treating those products. Maintain water-absorbing property which is not greater than that of untreated lumber.
2. Hardware
   a. Fastener for securing deck timbers to cross beams: Joist hanger nail galvanized in accordance with ASTM A 153; Cleveland Specialty Co., or accepted equivalent.
   b. Fastener for securing cross beams to support beams: Galvanized dome head drive spike or washer-head timber screw; Lewis Nut and Bolt Co.'s Sealtite, Cancar Div. of Textron Industries, Inc.'s Torx Truss Washer Head, or accepted equivalent.
   c. Fastener for securing support beams to concrete ties: Threaded hook bolt galvanized in accordance with ASTM A 153 after threading; Lewis Bolt and Nut Co.'s Sealtite having Sealtite washer nut and hook lock plate, or accepted equivalent.
   d. Fastener for securing flangeway timbers to direct fixation concrete: Anchor bolt, conforming to ASTM A 307 and hot-dip galvanized in accordance with ASTM A 153, and concrete insert.
3. Preservative solution for treating field-cut timber: 0.9 Osmose Solution, or accepted equivalent.
4. Anti-slip coating: Two-part epoxy resin and graded aggregate dispersed throughout epoxy. Not less than 100 percent of aggregate shall pass the No. 30 sieve and not less than 95 percent shall pass the No. 50 sieve; Tasa Corp., or accepted equivalent.
5. Sealant: Asphalt mastic conforming to ASTM D 491, or accepted equivalent.
6. Bonding agent: Preco Co.'s Rockweld C, or accepted equivalent.
7. Concrete formwork: CONCRETE FORMWORK.
8. Concrete reinforcement: CONCRETE REINFORCEMENT.
9. Portland cement concrete: Class 3000 PORTLAND CEMENT CONCRETE.
10. Grout: Nonshrink type conforming to CRD C621.
11. Asphaltic concrete
   a. Bituminous prime coat: Cutback asphalt MC250.
   b. Bituminous tack coat.
   c. Base course: Asphaltic Concrete "Base".
   d. Surface course: Asphaltic Concrete “Surface”.
12. Fabrication
   a. Orient timber heartwood face downward.
   b. Cut beams square. Bevel outside ends of timber decking and flangeway timbers four inches at 45 degrees.
   c. Drill holes for anchor bolts; countersink ends of holes for washers and nuts. Drill no holes the centerline of which is less than two inches from edge of timber.
   d. Pressure-treat cut and drilled timbers by the Osmose K-33 method in accordance with AWPI; develop preservative retention of not less than 0.25 pound per cubic foot.

e. Assemble crosswalk with heartwood facing downward and ends of decking timbers, cross-beams, and support beams being aligned. Nail decking to cross-beams with two nails per timber.

B. Grade Crossing
1. Timber: Maple, gum, or birch.
2. Fastener for securing timber flangeway to wood tie: Dome-head drive spike; Lewis Nut and Bolt Co.'s Sealtite, or accepted equivalent.
3. Preservative: Creosote type.
4. Asphaltic concrete
a. Bituminous prime coat: Cutback asphalt MC250.
b. Base course: Asphaltic Concrete "Base".
c. Surface course: Asphaltic Concrete "Surface".
5. Fabrication
a. Orient flangeway timber heartwood to face downward.
b. Cut timbers square except bevel ends of flangeway timbers, which will not abut other timber, four inches at 45 degrees. Notch flangeway timber to clear tie plate hardware by not less than 1/2 inch.
c. Pressure-treat cut and drilled timbers in accordance with AREA MRE Chapter 3, Part 9.

1.3 EXECUTION

A. Examination: Examine surfaces on which crosswalk and grade crossing will be placed.
1. Ensure that track has been raised and aligned to its final alignment and profile and has been accepted by the Owner.
2. Ensure that ballast has been dressed to final cross section.

B. Surveying: Survey installed CWR; determine its horizontal and vertical track alignments.

C. Preparation
1. Remove loose material from tie, rail, and rail fastenings.
2. If wood products have been field-drilled and field-cut, coat drilled and cut surfaces with preservative solution immediately after holes have been drilled and surfaces have been cut.

D. Installation
1. Anchor timbers; seat solidly.
2. Drive spikes and nails, and torque screws; make timber connections rigid.
3. Fill space between countersunk timber and bolt and washer with sealant.
4. Apply not less than 1/16 inch of anti-slip compound to wearing surfaces of flangeway timber and crosswalk timber decking in accordance with anti-slip manufacturer's printed instructions.
5. Place concrete formwork in accordance with CONCRETE FORMWORK. Place concrete reinforcement in accordance with CONCRETE REINFORCEMENT. Place concrete in accordance with CAST-IN-PLACE CONCRETE. Broom- finish concrete surface in accordance with UNFORMED- CONCRETE FINISHES.
6. Tolerances
a. Top of flangeway and timber, vertical depression below top of rail: plus 1/4 inch, minus zero.
b. Clearance between sides of flangeway and timbers and edge of rail: plus 1/4 inch, minus zero.
c. Difference in elevation between surfaces of flangeway and timber and surface of abutting paving: 1/8 inch.

END OF SECTION 34 01 23 33i

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Task	Specification	Specification Description
34 05 43 00	03 01 30 00	Maintenance of Cast-in-Place Concrete
34 05 43 00	03 41 00 00	Precast Structural Concrete
34 05 43 00	05 12 00 00	Structural Steel Framing
34 05 43 00	05 40 00 00	Cold-Formed Metal Framing
34 05 43 00	05 50 00 00	Metal Fabrications

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SECTION 34 41 13 00 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Cord reels and fittings.
9. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies covers and cover plates referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
8. Section 260936 "Modular Dimming Controls" for multiscene and multipreset dimming controls.
9. Section 260943.16 "Addressable Luminaire Lighting Controls" for network lighting control solid-state devices.
10. Section 260943.23 "Relay-Based Lighting Controls" for network lighting control relay devices.
11. Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches" for additional wiring device products.
12. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for additional wiring device products.
13. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for additional wiring device products.
14. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for additional wiring device products.
15. Section 262726.37 "Receptacles with Arc-Fault and Ground-Fault Protective Devices" for additional wiring device products.
16. Section 262726.39 "Locking Receptacles" for additional wiring device products.
17. Section 262726.41 "Pin-and-Sleeve Receptacles" for additional wiring device products.

18. Section 262726.43 "Special-Purpose Power Outlet Assemblies" for additional wiring device products.
19. Section 262726.51 "Connectors, Cords, and Plugs" for additional wiring device products.
20. Section 270528 "Pathways for Communications Systems" [**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 DEFINITIONS

A. AFCI: Arc-Fault Circuit Interrupter.

B. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

C. GFCI: Ground-Fault Circuit Interrupter.

D. SPD: Surge Protective Device.

E. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at the Project site**][**by web conference**].

B. Preinstallation Coordination Meeting(s): For ceiling-mounted cable reels. Conduct meeting [**as videoconference**][**at Project site**].

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect [**Construction Manager**][**and the Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

2. Include manufacturer's sample extended warranty language.

B. Samples: One for each type of product specified, in each finish and color specified for [**public spaces**] .

C. Shop Drawings: Prepare and submit wiring diagrams for duplex straight-blade receptacles with integral switching means.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

2. Lighting Control Documentation: Floor plans indicating the following information:

a. As-installed locations of switches and dimmers.
b. Lighting zones and control strategy for each switch or dimmer, including unoccupied time-delay setting for shut-off and override time-delay setting for shut-off.
c. Multilevel or dimming range capability for each switch or dimmer.
d. Which switches or dimmers are operated by occupancy sensors, vacancy sensors, daylighting sensors, or time clocks.

3. Record floor plan Drawings indicating as-installed locations of switches and dimmers, indicating lighting zone's each device control, to verify extent of ability of the installed Work to provide occupant control for customizing environment.
4. Record floor plan Drawings indicating as-installed locations of uncontrolled and marked controlled receptacles superimposed on office furniture layout, to verify extent of ability of the installed Work to provide each occupant ability to select at least one uncontrolled receptacle and at least one controlled receptacle for powering workspace equipment. Indicate locations of UL-approved relocatable power taps and power strips, indicating means of securing protection from damage and accessibility for inspection. Indicate locations of temporary extension cords, indicating plan for replacing them with permanent wiring within 90 days.

5. Product Data for Automated Demand Response Controls: For automated demand response controls connected to [**HVAC systems,**][**lighting systems,**][**automatic receptacle controls,**][**service water heating,**][**and**][**electric vehicle supply equipment**] .

E. Field QC Reports: For specified tests and inspections.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: For wiring devices.

B. Field Reports: Manufacturer's field reports for field QC support.

1.6 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Special manufacturer extended warranty for devices and cord reels and fittings.
2. Special installer extended warranty for devices and cord reels and fittings.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish straight-blade receptacles and connectors, cords, and plugs.

B. Special Tools: Furnish straight-blade receptacles and connectors, cords, and plugs.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able

to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.9 WARRANTY FOR DEVICES

A. Special Installer Extended Warranty: Installer warrants that installed devices perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to the Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Three**][**Four**][**Five**] years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

2. Follow-On Extended Warranty Period: [**Eight**] years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**] , freight prepaid.

1.10 WARRANTY FOR CORD REELS AND FITTINGS

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to repair or replace assemblies that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: [**Two**][**Three**][**Four**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Three**][**Four**][**Five**] years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

2. Follow-On Extended Warranty Period: [**Eight**] years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**] , freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Description:

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Description:

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance**

with NEMA WD 1][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .

b. Configuration:

1) General-duty, 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
2) General-duty, 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
3) Extra-heavy-duty, 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
4) Extra-heavy-duty, 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
5) Extra-heavy-duty, 120-277 V, 30 A, [**single pole**][**double pole**][**three way**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Toggle Switch with Forked Key Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Black**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
2) 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
3) 120-277 V, 30 A, [**single pole**][**double pole**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. Rocker Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) 120-277 V, 15 A, [**single pole**][**three way**][**four way**] .
      2) 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

   c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Rocker Switch with Nightlight :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration: 120-277 V, 20 A, [**single pole**][**three way**][**four way**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Type I Dimmer Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**GE Lighting; a Savant Company**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lutron Electronics Co., Inc**]
f. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. General-Use Switch Dimmers: UL CCN EOYX and UL 1472.

4. Standard Features:

a. UL 1472 Type I dimmer.

b. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
c. Switch Style: [**Toggle**][**Rocker**][**Push button**] .
d. Dimming Control Style: [**Slide**][**Rotary**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Air-Gap Fan-Speed Controller Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Fan-Speed Controls: UL CCN GQHG and UL 1917.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.5 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

A. Single Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**][**NEMA 5-30R**][**NEMA 5-50R**] .
2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
3) General-duty, [**NEMA 6-15R**][**NEMA 6-20R**][**NEMA 6-30R**][**NEMA 6-50R**] .
4) General-duty, smooth face, NEMA 6-20R.
5) General-duty, [**NEMA 14-30R (Dryer)**][**NEMA 14-50R (Range)**] .
6) Heavy-duty, [**NEMA 5-30R**][**NEMA 5-50R**] .
7) Heavy-duty, [**NEMA 6-30R**][**NEMA 6-50R**] .
8) Heavy-duty, [**NEMA 7-20R**][**NEMA 7-30R**][**NEMA 7-50R**] .
9) Heavy-duty, [**NEMA 14-20R**][**NEMA 14-30R (Dryer)**][**NEMA 14-50R (Range)**][**NEMA 14-60R**] .
10) Heavy-duty, [**NEMA 15-20R**][**NEMA 15-30R**][**NEMA 15-50R**][**NEMA 15-60R**] .
11) Heavy-duty, [**NEMA 18-20R**][**NEMA 18-30R**][**NEMA 18-50R**][**NEMA 18-60R**] .
12) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
13) Extra-heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant, Clock Hanger Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

   a. Finish: [**White nylon**][**Ivory nylon**][**Brass**][**Stainless steel**][**Brushed brass**][**Nickel plated**] .
   b. Configuration: Recessed, smooth wallplate; [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

C. Tamper-Resistant, Floor-Mounted Display Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

   a. Finish: [**Brushed brass**][**Nickel plated**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

2.6 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Leviton Manufacturing Co., Inc.**]
   c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
3) General-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
4) General-duty, smooth face, [**NEMA 6-15R**][**NEMA 6-20R**] .
5) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
6) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
7) Heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
8) Heavy-duty, smooth face, NEMA 6-15R.
9) Heavy-duty, NEMA 7-15R.
10) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
11) Extra-heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
12) Extra-heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
13) Extra-heavy-duty, smooth face, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      4) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      5) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Isolated Ground Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Leviton Manufacturing Co., Inc.**]
   b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      4) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      5) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      6) Extra heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Isolated Ground Duplex Straight-Blade Receptacle with Type 3 Surge Protective Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration: Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-A ports.
2) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-C ports.
3) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; one USB-A port; one USB-C port.
4) General-duty, smooth face, two USB-A ports.
5) General-duty, smooth face, four USB-A ports.

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Wired Full-Controlled Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles with Integral Switching Means: UL CCN RTXI and UL Subject 498B.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

G. Wired Half-Controlled Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles with Integral Switching Means: UL CCN RTXI and UL Subject 498B.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.7 HOSPITAL-GRADE STRAIGHT-BLADE RECEPTACLES

A. Hospital-Grade, Non-Ferrous Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration: Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Leviton Manufacturing Co., Inc.**]
   c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
    b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
    b. Configuration:

        1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
        2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
        3) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
        4) Extra-heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

    a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Hospital-Grade, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
    b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance**

with NEMA WD 1][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

b. Configuration:

1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Hospital-Grade, Tamper-Resistant, Isolated Ground Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Leviton Manufacturing Co., Inc.**]
b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration:

1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Pass & Seymour; Legrand North America, LLC**]
   d. >

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration:

      1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-A ports.
      2) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-C ports.
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; one USB-A port; one USB-C port.

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.8 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]

b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Outlet Branch-Circuit Type AFCIs: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI and GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Outlet Branch-Circuit Type GFCIs and AFCIs: UL CCN KCXX, UL 498, UL 943, UL 1699, and UL Subject 1699A.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. General-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
    b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

    a. Cover Plate: **0.060 inch** **(1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Hospital-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Hospital-Grade, Isolated Ground, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.9 LOCKING RECEPTACLES

A. UL RTRT - NEMA, 125 V, Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ABB Electrification Installations Products**]
    b. [**Eaton, Wiring Devices; Arrow Hart**]
    c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

    a. Device Color: Black with yellow voltage indication on face.
    b. Configuration: 2 pole, 3 wire, grounding, [**NEMA L5-15R**][**NEMA L5-20R**][**NEMA L5-30R**] .

B. UL RTRT - NEMA, 125 V, Isolated Ground Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

    a. Device Color: Black with yellow voltage indication on face.
    b. Configuration: 2 pole, 3 wire, grounding, [**NEMA L5-15R**][**NEMA L5-20R**][**NEMA L5-30R**] .

C. UL RTRT - NEMA, 250 V, Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

    a. Device Color: Black with blue voltage indication on face.
    b. Configuration:

        1) 2 pole, 3 wire, grounding, [**NEMA L6-15R**][**NEMA L6-20R**][**NEMA L6-30R**] .
        2) 3 pole, 4 wire, grounding, [**NEMA L15-20R**][**NEMA L15-30R**] .
        3) 4 pole, 4 wire, non-grounding, [**NEMA L18-20R**][**NEMA L18-30R**] .
        4) 4 pole, 5 wire, grounding, [**NEMA L21-20R**][**NEMA L21-30R**] .

D. UL RTRT - NEMA, 250 V, Isolated Ground Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

a. Device Color: Black with blue voltage indication on face.
b. Configuration:

1) 2 pole, 3 wire, grounding, [**NEMA L6-15R**][**NEMA L6-20R**][**NEMA L6-30R**] .
2) 3 pole, 4 wire, grounding, [**NEMA L15-20R**][**NEMA L15-30R**] .
3) 4 pole, 5 wire, grounding, [**NEMA L21-20R**][**NEMA L21-30R**] .

2.10 PIN-AND-SLEEVE RECEPTACLES

A. UL QLIW - C2 Series, 125/250 V, Pin-and-Sleeve Receptacles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
c. [**Eaton, Wiring Devices; Arrow Hart**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Pin-and-Sleeve Type Receptacles: UL CCN QLIW; including UL 1682.

4. Standard Features:

a. Series: UL 1686 Series C2 and IEC 60309-2 Series II.
b. Voltage Rating: 125/250 V.
c. Configuration:

1) 2 pole, 3 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A**] .
2) 3 pole, 4 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .
3) 4 pole, 5 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .

B. UL QLIW - C2 Series, 480 V, Pin-and-Sleeve Receptacles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
c. [**Eaton, Wiring Devices; Arrow Hart**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Pin-and-Sleeve Type Receptacles: UL CCN QLIW; including UL 1682.

4. Standard Features:

   a. Series: UL 1686 Series C2 and IEC 60309-2 Series II.
   b. Voltage Rating: 480 V.
   c. Configuration:

      1) 2 pole, 3 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A**] .
      2) 3 pole, 4 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .
      3) 4 pole, 5 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .

2.11 CORD REELS AND FITTINGS

A. Power Outlet Cord Management Assembly :

1. Source Limitations: Obtain all components for each power outlet cord management assembly from single manufacturer.
2. General Characteristics: Provide the following specified products with fabricated power outlet cord management assembly:

   a. Cord Management System:

      1) Spring-driven commercial/industrial-use cord reel .
      2) Cord reel for use in Class I Group D hazardous location .

   b. Termination Fitting:

      1) the Owner-furnished fitting.

      2) Outdoor-use, watertight, sealed cord connector;

3. Accessories:

   a. Mounting: [**Ceiling**][**Wall**][**Floor**] mounted.

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**] .

B. Spring-Driven Commercial/Industrial-Use Cord Reel, 14 AWG Conductors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton**]
   b. [**Ericson Manufacturing Company**]
   c. [**Gleason Reel; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Cord and Cable Reels: UL CCN SBCV and UL 355.

3. Standard Features:

   a. Spring take-up retraction mechanism.

   b. Electrical Rating with Cable: 600 V, [**18 A**][**15 A**][**12 A**][**10.5 A**][**7.5 A**] .
   c. Color: [**Yellow**][**Black**][**White**].
   d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
   e. Ball stop.
   f. Pivot base.
   g. Spool Capacity:

      1) 14 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**][**70 ft (21.3 m)**] .

2) 14 AWG, three wires and equipment ground, [20 ft (6 m)][30 ft (9.1 m)][35 ft (10.7 m)][40 ft (12.2 m)][50 ft (15.2 m)][60 ft (18.3 m)][70 ft (21.3 m)] .
3) 14 AWG, five wires and equipment ground, [20 ft (6 m)][30 ft (9.1 m)][40 ft (12.2 m)][50 ft (15.2 m)][60 ft (18.3 m)] .
4) 14 AWG, seven wires and equipment ground, [20 ft (6 m)][30 ft (9.1 m)][40 ft (12.2 m)][50 ft (15.2 m)] .
5) 14 AWG, nine wires and equipment ground, [20 ft (6 m)][30 ft (9.1 m)] .
6) 14 AWG, eleven wires and equipment ground, [20 ft (6 m)][60 ft (18.3 m)] .

7) 14 AWG, two wires and equipment ground, [25 ft (7.6 m)][35 ft (10.7 m)][45 ft (13.7 m)][90 ft (27.4 m)][100 ft (30.5 m)][125 ft (38.1 m)][150 ft (45.7 m)] .
8) 14 AWG, three wires and equipment ground, [25 ft (7.6 m)][45 ft (13.7 m)][65 ft (19.8 m)][80 ft (24.4 m)][90 ft (27.4 m)][100 ft (30.5 m)][125 ft (38.1 m)][150 ft (45.7 m)] .
9) 14 AWG, five wires and equipment ground, [25 ft (7.6 m)][35 ft (10.7 m)][45 ft (13.7 m)] .
10) 14 AWG, seven wires and equipment ground, [25 ft (7.6 m)][35 ft (10.7 m)][45 ft (13.7 m)] .
11) 14 AWG, nine wires and equipment ground, [25 ft (7.6 m)][50 ft (15.2 m)] .
12) 14 AWG, eleven wires and equipment ground, [25 ft (7.6 m)][30 ft (9.1 m)] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

C. Spring-Driven Commercial/Industrial-Use Cord Reel, 12 AWG Conductors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Appleton; Emerson Electric Co., Automation Solutions**]
   b. [**Ericson Manufacturing Company**]
   c. [**Gleason Reel; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Reelcraft Industries Inc**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Cord and Cable Reels: UL CCN SBCV and UL 355.

3. Standard Features:

   a. Spring take-up retraction mechanism.

   b. Electrical Rating with Cable: 600 V, [**25 A**][**20 A**][**16 A**][**14 A**] .
   c. Color: [**Yellow**][**Black**][**White**].
   d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
   e. Ball stop.
   f. Pivot base.
   g. Spool Capacity:

      1) 12 AWG, two wires and equipment ground, [**20 ft (6 m)**][**25 ft (7.6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**] .
      2) 12 AWG, three wires and equipment ground, [**20 ft (6 m)**][**25 ft (7.6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**45 ft (13.7 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**][**100 ft (30.5 m)**] .
      3) 12 AWG, five wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
      4) 12 AWG, seven wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**] .

      5) 12 AWG, two wires and equipment ground, [**35 ft (10.7 m)**][**45 ft (13.7 m)**][**70 ft (21.3 m)**][**80 ft (24.4 m)**][**90 ft (27.4 m)**][**100 ft (30.5 m)**][**125 ft (38.1 m)**][**150 ft (45.7 m)**] .
      6) 12 AWG, three wires and equipment ground, [**35 ft (10.7 m)**][**70 ft (21.3 m)**][**80 ft (24.4 m)**][**90 ft (27.4 m)**][**125 ft (38.1 m)**] .
      7) 12 AWG, four wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
      8) 12 AWG, five wires and equipment ground, [**25 ft (7.6 m)**][**35 ft (10.7 m)**][**45 ft (13.7 m)**] .
      9) 12 AWG, seven wires and equipment ground, [**25 ft (7.6 m)**][**40 ft (12.2 m)**] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

D. Spring-Driven Cord Reel for Use in Class I Group D Hazardous Locations :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Appleton; Emerson Electric Co., Automation Solutions**]
   b. [**Conductix-Wampfler USA; Delachaux Group**]
   c. [**KH Industries, Inc.**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Cord Reels for Use in Hazardous Locations: UL CCN SAOX and UL 355.

3. Standard Features:

    a. Spring take-up retraction mechanism.

    b. Electrical Rating with Cable: 600 V, [**35 A**][**25 A**][**20 A**][**18 A**][**15 A**] .
    c. Color: [**Yellow**][**Black**][**White**].
    d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
    e. Ball stop.
    f. Pivot base.
    g. Spool Capacity:

        1) 14 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**50 ft (15.2 m)**] .
        2) 14 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**50 ft (15.2 m)**] .
        3) 12 AWG, two wires and equipment ground, [**30 ft (9.1 m)**][**50 ft (15.2 m)**] .
        4) 14 AWG, two wires and equipment ground, [**40 ft (12.2 m)**][**60 ft (18.3 m)**][**70 ft (21.3 m)**] .
        5) 14 AWG, three wires and equipment ground, [**40 ft (12.2 m)**][**60 ft (18.3 m)**] .
        6) 12 AWG, two wires and equipment ground, [**20 ft (6 m)**][**40 ft (12.2 m)**][**60 ft (18.3 m)**] .
        7) 12 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**] .
        8) No. 10 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
        9) No. 10 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

    a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

    b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

    c. Component Amplification Factor (ap): [**1.0**][**2.5**].

    d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

    e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

2.12 CONNECTORS, CORDS, AND PLUGS

A. Outdoor-Use, Watertight, Sealed Cord Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ericson Manufacturing Company**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Fuseless Attachment Plugs: UL CCN AXUT and UL 498.

3. Standard Features:

a. Configuration:

1) NEMA 5-15 [**with diagnostic LED indicator**] .
2) NEMA 5-20 [**with diagnostic LED indicator**] .
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20 [**with diagnostic LED indicator**] .
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.
18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

2.13 MAINTENANCE MATERIAL ITEMS FOR STRAIGHT-BLADE RECEPTACLES

A. Extra Stock Material: Furnish to the Owner extra materials [**from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. [**Include the following:**]

1. SPD Receptacles: Equal to [**10**] percent of quantity installed for each kind specified, but no fewer than [**one**] units.
2. Controlled Receptacles: Equal to [**10**] percent of quantity installed for each kind specified, but no fewer than [**one**] units.

B. Special Tools: Furnish to the Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to controlled receptacles, that are packaged with protective covering for storage on-site and identified with labels describing contents.

2.14 MAINTENANCE MATERIAL ITEMS FOR CONNECTORS, CORDS, AND PLUGS

A. Extra Stock Material: Furnish to the Owner extra materials [**from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. [**Include the following:**]

1. Cord Connectors: [**One**] of each kind.

B. Special Tools: Furnish to the Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to cord connectors, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for the Owner-furnished equipment are compatible with mating attachment plugs on equipment.

B. Cord Reels and Fittings:

1. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.
2. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONTROLLED AND UNCONTROLLED RECEPTACLES

A. Private and Open Office Spaces:

1. Uncontrolled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one uncontrolled receptacle is selected for installation not greater than **6 ft. (1.8 m)** from each workstation.
2. Controlled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one controlled receptacle is selected for installation not greater than **6 ft. (1.8 m)** from each workstation.
3. Contact Architect for resolution of discrepancies between these requirements and Drawings, as directed by the Owner.

3.3 SELECTION OF GFCI RECEPTACLES

A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.4 INSTALLATION OF GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Life Safety and Means of Egress Work: NFPA 101.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Wiring Devices: NECA NEIS 130.
6. Mounting Heights: NECA NEIS 1.
7. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification:

a. Identify cover or cover plate for device with panelboard identification and circuit number.

b. Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.5 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.

11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.

1) Identify cover or cover plate for device with panelboard identification and circuit number.

2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

2. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.

3.6 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.

1) Identify cover or cover plate for device with panelboard identification and circuit number.

2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.7 INSTALLATION OF PIN-AND-SLEEVE RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in UL 1686.
11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.

1) Identify cover or cover plate for device with panelboard identification and circuit number.

2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.8 INSTALLATION OF CORD REELS AND FITTINGS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Hot Work: NFPA 51B.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

3.9 INSTALLATION OF CONNECTORS, CORDS, AND PLUGS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Work in ITE Rooms: NFPA 75.
6. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

3.10 FIELD QUALITY CONTROL OF GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections in accordance with manufacturers' published instructions.

D. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.11 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.12 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.13 FIELD QUALITY CONTROL OF PIN-AND-SLEEVE RECEPTACLES

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]

as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Measure line voltage.
3. Measure percent voltage drop.
4. Measure ground impedance, which must be not greater than 2 ohms.
5. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.14 FIELD QUALITY CONTROL OF CORD REELS AND FITTINGS

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections indicated in manufacturer's published instructions.

D. Nonconforming Work:

1. Components and assemblies will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.15 FIELD QUALITY CONTROL OF CONNECTORS, CORDS, AND PLUGS

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections indicated in manufacturer's published instructions.

D. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.16 SYSTEM STARTUP FOR GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.17 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within [**12**] months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] visits to the Project during other-than-normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.18 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

B. Cord Reels and Fittings: After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

C. Connectors, Cords, and Plugs: After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

END OF SECTION 34 41 13 00

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Task	Specification	Specification Description
34 41 33 00	34 01 23 33i	Roadway Crossing Control Equipment
34 71 00 00	34 01 23 33i	Roadway Crossing Control Equipment

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SECTION 34 71 13 00 - ACTIVE VEHICLE BARRIERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for active vehicle barriers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings: Installation, Equipment, and Electrical Work
a. Detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. For Federal work, detail drawings shall include a copy of the Department of State certificate of barrier performance.
2. Product Data:
a. Vehicle Barriers: A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.
b. Spare Parts: Spare parts data for each different item of material and equipment used, after approval of the detail drawings. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.
3. Test Reports
a. Field Testing: Test reports in booklet form showing all field tests, including component adjustments and demonstration of compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.
4. Operation and Maintenance Data
a. Vehicle Barriers: Operating and Maintenance Instructions
1) Six copies of operation and maintenance manuals, a minimum of 2 weeks prior to field training. One complete set prior to performance testing and the remainder upon acceptance. Manuals shall be approved prior to acceptance. Operation manuals shall outline the step-by-step procedures required for system startup, operation, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include synthetic biodegradable hydraulic oil types to be used for ambient temperature ranges of minus 30 degrees F (minus 34 degrees C) to 150 degrees F (plus 66 degrees C) to cover winter operation, summer operation, and ambient temperature ranges in between.

C. General Requirements
1. Performance levels shall be based on the following:
a. The Department of State (DOS) publication SD-SDT-02.01 Specification for Vehicle Crash Testing of Perimeter Barriers and Gates (April 1985) in which:
1) Impact Conditions:

Condition Designation	Vehicle Weight	Impact Speed	Kinetic Energy
K4	15,000 lb (6,800 kg)	30 mph (48 km/h)	450,000 ft-lb (610 kJ)
K8	15,000 lb (6,800 kg)	40 mph (65 km/h)	800,000 ft-lb (1084 kJ)
K12	15,000 lb (6,800 kg)	50 mph (80 km/h)	1,250,000 ft-lb (1695 kJ)

2) Performance Levels:
   a) L 3.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 3 feet (1 m) permitted.
   b) L 2.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 20 feet (6 m) is permitted.
   c) L 1.0 Vehicle is disabled and does not travel more than 50 feet (15 m) after impact.

2. Vehicle Barriers furnished shall in all respects be identical to the unit tested and certified except for the width of the vehicle barrier, which is as indicated and except for bollards which have a diameter based on a required crash rating. Crash test shall be performed and data compiled by an approved independent testing agency. Test vehicle shall not vault or penetrate the barrier during the test. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier.

D. Nameplates
1. Nameplate data shall be permanently attached to each vehicle barrier. The data shall be legibly marked on corrosion-resistant metal plates and shall consist of at least the following:
   a. Manufacturer's name.
   b. Model number.
   c. Serial number.
   d. Date of manufacture.

E. Delivery And Storage
1. Components placed in storage shall be protected from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Structural materials shall be stored on sleepers or pallets and shall be protected from rust and objectionable materials such as dirt, grease, or oil.

F. Spare Parts
1. A manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, shall be provided with each barrier to facilitate 1 year of normal operation. Particular consideration shall be given to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

G. Manufacturer's Services
1. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

1.2 PRODUCT

A. Retractable Barriers: When in the raised position, the total retractable barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be 144 inches (3.66 m) wide. When in the lowered position, the retractable barrier shall extend no more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) wheel load. Design for this load shall be in accordance with AASHTO HB-17.
1. Powered Retractable Barrier: The retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable

of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being lowered from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

a. Failure Modes of Operation: The system shall be designed to remain in the last commanded position in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic barriers without power.

b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed **OR** totally enclosed fan cooled, **as directed**, enclosures. All couplings, motor shafts, gears, and other moving parts shall be fully guarded in accordance with 29 CFR 1910 Subpart O. Guards shall be removable without disassembling the guarded unit. For multiple barriers operated from a single hydraulic unit it is highly recommended that the electric motor be 3-phase.

c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure. The system shall not require continuous running of the motor to stay in the raised position, excluding the use of manual pinning to do so.

d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
   1) Flexible hydraulic lines shall be in accordance with SAE J517.
   2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Retractable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Barrier should be capable of being locked in the down position.

B. Retractable Bollards: The total bollard height when in the raised position shall be no less than 30 inches (750 mm) above the roadway surface and shall have an outside diameter of no less than 8 inches (200 mm). A bollard system shall consist of a minimum of 3 bollards spaced no more than 36 inches (915 mm) from centerline to centerline of bollards across a 10 foot (3.0 m) roadway. Bollards in the lowered position shall be capable of supporting a 16,000 pound (71 kN) wheel load each. Design for this load shall be in accordance with AASHTO HB-17. Retractable bollards shall withstand a K4 **OR** K8 **OR** K12, **as directed**, Impact Condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

1. Powered Retractable Bollards: The retractable bollard shall be capable of 300 complete up/down cycles per hour. Bollards shall be capable of being raised or lowered within a 3 to 15-second range during normal use and within 2.5 seconds for emergency operations.
   a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic and/or mechanical barriers without power.
   b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. For multiple barriers being operated from a hydraulic power unit it is highly recommended that the electric motor be 3-phase.
   c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for period of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
   d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range, if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
      1) Flexible hydraulic lines shall be in accordance with SAE J517.
      2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
   e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Retractable Bollards: Manual bollards shall be capable of being raised and lowered utilizing a recessed handle on the top surface of the bollard or a manual hydraulic pump, either requiring a maximum 60 pounds (267 N) of force. A mechanism, that is lockable, shall be provided to secure the bollard in either the full "UP" or full "DOWN" position.

C. Crash Gate: The crash gate shall consist of steel buttresses anchored into the ground and an above grade assembly consisting of a heavy steel structure or a combination of heavy steel and structural aluminum capable of being opened and closed. The height of the gate shall be a minimum of 84 inches (2.1 m) from the road surface to the top of the gate frame. The length shall close and protect a minimum 120 inch (3.0 m) clear opening. The maximum clear opening between the gate frame and end posts, between the bottom of the gate and finished grade, and between any grill work shall be 3 inches (75 mm).
   1. Powered Crash Gate: The gate movement shall be controlled by an electro-mechanical gate operator **OR** a hydraulic gate operator, **as directed**, consisting of an operator unit with required control circuits and operator station. The control and operating voltage shall be 24 vac (nominal) or, as an option 24 vdc. A remote control master station shall be capable of driving the gate at minimum 48 fpm (14.6 m per minute) for a slide gate or 6 degrees per second for a swing gate. Unless otherwise indicated, motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. Crash gate shall withstand a 15,000 pound (6804 kg) vehicle at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum barrier deflection or vehicle penetration of 3 feet (1 m).

a. Failure Mode of Operation: The system shall be designed to prevent opening of the crash gate in the event of electrical or mechanical failure. A disconnect system for the gate drive shall be provided to allow manual operation of the barrier in the event of a power outage.

b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity within its operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
   1) Flexible hydraulic lines shall be in accordance with SAE J517.
   2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Crash Gate: The manual crash gate shall be capable of being hinged from either side. Hinge points of both buttresses shall each contain a locking pin with padlock acceptance for securing the crash gate in the closed position. The crash gate shall withstand a 10,000 pound (4535 kg) vehicle at impact speed of 50 mph (80 km/hour), with maximum gate deflection or vehicle penetration of 10 feet (3 m) 15,000 pound (6804 kg) vehicle traveling at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with a maximum gate deflection or vehicle penetration of up to 3 feet (1 m).

D. Crash Beam: The crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum vehicle penetration of 20 feet (6 m) 10,000 pound (4535 kg) vehicle at impact speed of 15 mph (24 km/hour), with a maximum vehicle penetration of 10 feet (3 m).

1. Powered Crash Beam: The crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.

a. Failure Mode of Operation: A disconnect system for the crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.

b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

1) Flexible hydraulic lines shall be in accordance with SAE J517.
2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable exterior door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Crash Beam: The crash beam shall be manually raised and lowered with the aid of a counterbalanced end requiring approximately 60 pounds (267 N) of force.

E. Portable Retractable Barrier: The portable retractable barrier shall be transportable and capable of manual and/or electro-mechanical operation. When in the raised position, the total barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be up to 144 inches (3.66 m wide). The barrier shall be equipped with entrance/exit ramps when the barrier extends more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) pound wheel load. Design for this load shall be accordance with AASHTO HB-17.

1. Powered Portable Retractable Barrier: The portable retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being closed from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Portable retractable barrier, when impacted by a 15,000 pound (6,800 kg) vehicle at impact speed of 50 mph (80 km/hour) shall disable the vehicle and allow it to travel no more than 50 feet (15.2 m) after impact. Portable power assisted retractable barriers shall be equipped with on and off ramps for smooth transition between surfaces when the barrier extends more than 5/8 inch (16 mm) above the roadway surface.
   a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electric, or mechanical failure. A manual pump shall be included for operation of hydraulic and/or mechanical barriers without power.
   b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures.
   c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
   d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
2. Manual Retractable Portable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position and shall also be capable of being locked in the

"DOWN" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**

F. Portable Crash Beam: The portable crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 mph (48 km/hour), with maximum vehicle penetration and/or barrier deflection of 20 feet (6 m).

1. Powered Portable Crash Beam: The portable crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.
   a. Failure Mode of Operation: A disconnect system for the portable crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.
   b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
   c. Hydraulic Power Unit Enclosure: A weather resistant enclosure shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Portable Crash Beam: The crash beam shall be manually operated by means of a counter balanced system requiring approximately 60 pounds (267 N) of force.

G. Electrical Work: Motors, manual or automatic motor control equipment except where installed in motor control centers and protective or signal devices required for the operation specified herein shall be provided in accordance with YYYY597YYYY. All field wiring for loop detectors, communication lines, and power circuits shall have surge protection. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with YYYY597YYYY.

H. Control Panel: A control panel and control circuit shall be provided to interface between all barrier control stations and the power unit. A control panel shall be provided for the inbound lanes and a separate one for the outbound lanes where the barriers are located. The control station is defined as the main control panel and the remote control panel as shown. The control circuit shall contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. The control panel shall allow direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding **OR** swinging, **as directed**, gate limit switches. Loop controllers shall not cause an automatic barrier raise following power loss or restoration. The enclosure shall be as indicated on the drawings. All device interconnect lines shall be run to terminal strips.

1. Voltage: The control circuit shall operate from a 120 volt 60 **OR** 50, **as directed**, Hz supply. The control circuit voltage shall be 12 **OR** 24, **as directed**, ac **OR** dc, **as directed**, for all external control panels.

2. Main Control Panel: A main control panel shall be supplied to control barrier function. This panel shall have a key-lockable main switch with main power "ON" and panel "ON" lights. Buttons to raise and lower each barrier **OR** set of barriers, **as directed**, shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier **OR** set of barriers, **as directed**. An emergency fast operate circuit (EFO) shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. The EFO shall also be furnished with an EFO-active light and reset button. The main control panel shall have a key lockable switch to arm or disable the remote control panel. An indicator light shall show if the remote control panel is enabled.
3. Remote Control Panel: A remote control panel, one panel for the inbound lane(s) and a separate panel for the outbound lane(s), shall have a panel "ON" light that is lit when enabled by a key lockable switch on the main control panel. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier. The EFO shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. Activation of either EFO will operate all barriers. The EFO shall be interconnected with an EFO-active light. When the remote control panel EFO is pushed, operation of the barrier will not be possible from this panel until reset at the main control panel.

I. Miscellaneous Equipment
1. Safety Equipment
   a. Barrier Systems Sensors: The sensors shall be compatible with the barrier controller and shall function as part of a complete barrier control system. The barrier system sensors shall consist of the following:
      1) Suppression Loops - Two inductive loops whose outputs shall be used to prevent barriers raising when a vehicle is within a prescribed distance of the barrier. The output of the loops shall override all barrier rise signals until one second after a vehicle clears the suppression loop.
      2) Speed Loops - Two inductive loops whose output shall be used to signal the barrier controller of a vehicle approaching at a speed greater than the posted speed (25 mph (11.2 m/sec) or less (recommended)). The speed loops shall cause the barrier control panel to annunciate a warning sound alerting the guard to make a decision as to whether the barrier should be raised or not.
      3) Wrong Way Loops - Two inductive loops whose output shall be used to signal the barrier control panel to ennunciate a warning sound if a vehicle is attempting to enter the facility through the exit lane. The warning sound will alert the guard to make a decision as to whether the barrier should be raised or not.
   b. Traffic Lights: Red/yellow 8 inch (200 mm) traffic lights shall be supplied for each entrance and exit to alert motorists of the barrier position. Traffic lights are not required for manual barriers. The yellow flashing light shall indicate that the barrier is fully open. All other positions shall cause the light to show red. Brackets shall be supplied to allow the light to be mounted a minimum 4.5 feet (1.4 m) above the roadway pavement on a 3.5 inch (90 mm) outside diameter metal post or mounted directly on the crash gate.
2. Warning Annunciator: Provide a warning annunciator built into the barrier control panel that produces a pulsing audible sound when the speed loop detects a vehicle entering the facility with excess speed. Provide a warning annunciator built into the barrier control panel that produces a continuous sound whenever a wrong way loop detects a vehicle entering from the exit. The warning annunciator shall sound until a warning annunciator silence reset button is pressed.
3. Heater: A waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point shall be provided for de-icing and snow melting. The heater shall provide barrier operation to an ambient temperature of minus 40 degrees F (minus 40 degrees C). For retractable bollards, a 250-watt heater shall be provided for each bollard.
4. Signage: Signage shall read "Axle Weight Limit 9 Tons" and shall conform to FHWA SA-89-006 sign (R12.2).

5. Vertical Arm Gates (Traffic Arms): Vertical arm gates shall have an opening and closing time of less than or equal to 5 seconds. The gates shall be capable of 500 duty cycles per hour as a minimum. Gate shall operate the arm through 90 degrees. Gate operators shall be supplied with single phase 120 volt motors. Each entry lane shall be provided with a vertical arm gate. Each gate shall be capable of being operated from a remote open-close push button station in each guard booth and the gatehouse for the respective entry lane. Gates shall have a hand-crank, or other means, which will allow manual operation during power failures. Gate arms shall be constructed out of wood, steel, fiberglass, or aluminum, as specified by the manufacturer for the given lengths as shown on the drawings. Gate arms shall be covered with 16 inch (406 mm) wide reflectorized red and white sheeting. Each gate shall be furnished with a spare gate arm. Gate operator cabinets shall be constructed of galvanized steel, or aluminum and shall be painted manufacturers standard color as approved. Each gate operator shall be provided with an obstruction detector that will automatically reverse the gate motor when an obstruction is detected. The obstruction detector shall be any of the following 3 types: An electronic loop vehicle detector buried in the road, a photocell electric eye mounted on the gate operator, or a safety strip mounted on the lower edge of the arm. The detector system shall be automatically deactivated when the arm reaches the fully lowered position. Slab size and anchorage for gate operator shall be per manufacturer requirements.
6. Vehicle Barrier Vertical Arm Gate (Traffic Arm): A traffic arm, as a separate piece of equipment, will be included with each non-portable active vehicle barrier as part of the barrier safety operating system. This traffic arm shall automatically deploy (close) when the emergency up button is activated and open when the vehicle barrier is reset. This traffic arm will not be equipped with an automatic obstruction detector.

J. Finish: Surfaces shall be painted in accordance with requirements of YYYY267|268YYYY, as applicable. The roadway plate shall have a nonskid surface painted white with reflective red 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide red reflective stripes 4 inches (100 mm) apart. The barrier front shall be painted white and have 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide reflective red stripes 4 inches (100 mm) apart. The diagonal striping should point down and outward from the center of the device. Bollards shall be painted white with 2 **OR** 3, **as directed**, inch (50 **OR** 75, **as directed**, mm) wide reflective red diagonal stripes. The barrier crash gate shall be painted as specified by purchaser and the crash beam shall be painted white with 3 inch (75 mm) wide reflective red diagonal stripes.

K. Concrete: The concrete shall conform to YYYY73YYYY.

L. Welding: Welding shall be in accordance with AWS D1.1/D1.1M.

M. Pavement: After placement of the vehicle barrier, the pavement sections shall be replaced to match the section and depth of the surrounding pavement. Pavement shall be warped to match the elevations of existing pavement. Positive surface drainage, away from the vehicle barrier, shall be provided by pavement slope.

1.3 EXECUTION

A. Installation: Installation shall be in accordance with manufacturer's instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the equipment provided. The representative shall also be present during adjustment and testing of the equipment.

B. Hydraulic Lines: Buried hydraulic lines shall be placed in polyvinyl chloride (PVC) sleeves. Positive drainage shall be provided from the hydraulic power unit to the barrier for drainage of condensation within the PVC sleeve.

C. Pit Drainage: A drain connection and oil/water separator, **as directed**, shall be provided in each barrier that requires pit/vault type construction. Hookups between the storm drains shall be made. The self-priming sump pump shall have the capacity to remove minimum 150 gallons per minute (34 cubic meters per hour).

D. Electrical: All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to UL 486A. Roundhead screws and lockwashers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for the hydraulic power unit shall be capable of being locked in the power on and power off positions.

E. Field Testing: Upon completion of construction, a field test shall be performed for each vehicle barrier. The test shall include raising and lowering the barrier, both electrically and manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. the Owner shall be notified at least 7 days prior to the beginning of the field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Owner. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Owner. Adjustments and repairs shall be done by the Contractor under the direction of the Owner. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.

F. Field Training: A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of not less than 8 hours (for electrical/hydraulic operated units) or 1 hour (for manually operated units) of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

END OF SECTION 34 71 13 00

Task	Specification	Specification Description
34 71 13 00	34 01 23 33i	Roadway Crossing Control Equipment
34 71 13 13	34 71 13 26	Vehicle Guide Rails
34 71 13 13	34 71 13 00	Active Vehicle Barriers
34 71 13 13	34 01 23 33i	Roadway Crossing Control Equipment
34 71 13 16	34 71 13 26	Vehicle Guide Rails
34 71 13 16	34 71 13 00	Active Vehicle Barriers
34 71 13 16	34 01 23 33i	Roadway Crossing Control Equipment
34 71 13 19	34 71 13 00	Active Vehicle Barriers
34 71 13 19	34 01 23 33i	Roadway Crossing Control Equipment

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SECTION 34 71 13 26 - VEHICLE GUIDE RAILS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for beam-type guardrail. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Rail Elements, End Sections, and Fasteners
1. ARTBA technical bulletin No. 268-B.
2. Provide galvanized steel W-beam in accordance with AASHTO M-180, class A, type 1.
3. Shop curve rail elements when required radius of installation on horizontal curve is 150 ft (46 m) or less. Provide W-beam rail (ARTBA RE-3) with a flared end section (ARTBA RE-5), rounded end section (ARTBA RE-6) at each end of installations.
4. Provide standard back-up plates behind rail elements at all intermediate, non-splice posts when steel posts and blocks are used.
5. Galvanize the rail sections, including end sections, in accordance with ASTM A 525, coating G-210.

B. Posts
1. Wood: Provide wood posts with blocks, size as required by State DOT. Rough sawn or S4S timber of Douglas Fir or any other locally approved species that is either No. 1 grade or Select Structural grade when graded in accordance with the requirements for Timber and Posts as set forth in WWPA-01 may be used. Give all wood posts and blocks a preservative treatment in accordance with the requirements of AASHTO M-133. Cut to length and bore posts and blocks for bolt holes before treatment.
2. Steel: Provide steel posts with blocks. Fabricate posts and blocks from W6X9 structural steel shapes complying with the requirements of ASTM A 36. Fabricate in the shop, grind smooth all corners and edges, galvanize posts and blocks after fabrication in accordance with ASTM A 123.

C. Bolts, Nuts, and Washers
1. Provide galvanized bolts, nuts, and washers that meet common ARTBA standards, designed to develop the required joint strength. Provide bolts with rounded heads to provide minimum obstruction.
2. Provide galvanized steel bolts conforming to the requirements of ASTM A 307, nuts conforming to the requirements of ASTM A 563, Grade A or better and galvanized steel washers, all galvanized in accordance with the requirements of ASTM A 153. Provide high strength bolts conforming to the requirements of ASTM A 325 where needed.

D. Reflectors: Provide guardrail reflectors as indicated. Place the galvanized steel tabs with reflective sheeting at every post except no reflectors are to be placed along the guardrail end flares.

E. Breakaway Cable Terminal (BCT) Assemblies: Provide BCT assemblies in accordance with the ARTBA details and standards referenced on the details.

F. Concrete and Reinforcement for the Post Footings: In accordance with applicable sections of Division 3 Section “Cast-in-place Concrete".

1.3 EXECUTION

A. Guardrail: Erect steel beam-type guardrail in locations and to lines and grades as directed and in accordance with details indicated.

B. Erection
1. Firmly set posts spaced at 6 ft. 3 in. (1.9 m) centers to the required depth. Set posts by placing in hand or mechanically dug holes or by driving, with or without pilot holes. Backfill gaps around posts with approved material that is moistened and thoroughly compacted. Repair damaged roadway surfacing where pavement is disturbed.
2. Position the top of W-beam rail at 27 in. (0.69 m) above the finished roadway surface. Align rail both vertically and horizontally within 1/4-in. (6 mm) from the theoretical alignments. Lap the rail sections at posts, in the direction of traffic in the adjacent lane, and lap end sections on the face of the rail.
3. Exercise care to avoid damage to treated wood and galvanized steel parts. Repair or replace damaged parts at the Contractor's expense. Securely tighten all bolts in the finished guardrail. Toenail the wood blocks to wood posts with two 16 penny galvanized nails, one on each side of the top of the block.

END OF SECTION 34 71 13 26

Task	Specification	Specification Description
34 71 13 26	34 71 13 00	Active Vehicle Barriers
34 71 13 26	34 01 23 33i	Roadway Crossing Control Equipment
34 71 16 00	34 71 13 26	Vehicle Guide Rails
34 71 16 00	34 71 13 00	Active Vehicle Barriers
34 71 16 00	34 01 23 33i	Roadway Crossing Control Equipment
34 71 19 00	34 01 23 33i	Roadway Crossing Control Equipment
34 71 19 16	11 12 00 00	Parking Control Equipment
34 71 19 16	13 34 23 16	Fabricated Control Booths
34 71 19 16	34 01 23 33i	Roadway Crossing Control Equipment
34 82 29 00	33 42 00 00	Stormwater Conveyance

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SECTION 35 22 26 00 - SLUICE GATES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of sluice gate. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Sluice Gates: The sluice gate shall conform to the latest edition of AWWA 501 Sluice Gate Standards. Gate and accessories shall be as manufactured by Rodney Hunt Company or Hydrogate, or approved equal.
1. Sluice gates shall be cast iron, fully bronze mounted, and will have side wedges for seating head conditions and side, top and bottom wedges for unseating head conditions, where scheduled.
2. Liberal safety factors shall be used in the design of all the equipment. Working stresses shall not exceed the lower value of one-third (1/3) of the yield strength or one-fifth (1/5) of the ultimate strength of the material. The slide or disc shall be designed with a minimum safety factor of six (6). The sluice gates and operators shall be completely shop-assembled, inspected and tested to ensure proper fit and adjustment of all parts.
3. The sluice gate shall be substantially watertight under the design head conditions. The leakage shall not exceed 0.10 gallons per minute per foot of periphery for either the rated seating or unseating of the gate. The gate shall be rated for 60 feet of seating head and 35 feet of unseating head.
4. All materials used in the construction of the gates and appurtenances shall be designed for the application and shall conform to the following specifications.
5. Iron casting for wall thimbles, frame, disc, and guides, stem guides, floor stands and other items - ASTM A 126, Class B.
6. Bronze castings for wedges, thrust nut, and lift nut - ASTM B 584, Alloy 86500 or 87200.
7. Bronze for seat facings in frame and disc - ASTM B 21, Alloy 48200, extruded or ASTM B 139, Alloy 510, extruded.
8. Stainless steel for stems, stem couplings and fasteners - ASTM A 276, Type 304.
9. Silicon bronze for fasteners - ASTM B 98, Alloy 651, or 661.
10. Rubber for flush bottom seal - ASTM D 2000, grade AA625.

B. Frame: The frame shall be of cast iron, one-piece construction, flanged with rectangular or circular. All contact surfaces of the frame shall be machined. The frame shall have machined dovetailed grooves on the front face into which bronze seat facings shall be driven and machined to a 63 micro-inch finish. The back flange of the frame shall be machined to bolt directly to the machined face of the “F” type wall thimble. Frames for the sluice gates subject to unseating heads shall have integrally cast pads machined with keyways to receive top and bottom wedge seats.

C. Disc: The disc shall be of cast iron, one-piece construction rectangular with integrally cast vertical and horizontal ribs. The disc shall have a minimum thickness of 3/4 inch on gates which are 18 inches in diameter or larger. A heavy vertical reinforcing rib along each side shall be provided to ensure rigidity between the side wedges. All interior vertical ribs shall be of equal depth and shall not have any horizontal jogs along their entire length. Spacing of horizontal ribs shall not exceed 12 inches. The maximum deflection of horizontal ribs based on a working stress of 6,000 pounds per square inch for cast iron shall not exceed 0.07 inch under design pressure. The disc shall have machined dovetailed grooves on the seating face into which bronze seat facings shall be driven and machined to a 63 micro-inch finish. A tongue on each side, extending the full length of the disc, shall be machined on all sides

with a 1/8 inch clearance maintained between the disc tongue and the gate guide groove. Wedge pads for side wedges and for top and bottom wedges when required, shall be cast integrally on the disc and machined to receive the adjustable bronze wedges. A heavily reinforced nut pocket shall be cast integrally on the vertical centerline and above the horizontal center and be of such shape as to receive the square backed bronze thrust nut.

D. Guides: The guides shall be one piece, integrally cast type, designed to withstand the total thrust due to the water pressure and the wedging action. The guides shall be either bolted onto or integrally cast with the frame. The guides shall be machined on all contact surfaces and a groove shall be machined along the entire length of the guide to allow not more than 1/8 inch clearance between the disc tongue and the guide groove. The guides shall be of such length as to retain and support at least one-half (1/2) of the disc in the full open position. The bolt-on guides shall be attached to the frame with silicon bronze or stainless steel studs and nuts and shall be doweled to prevent any relative motion between the guides and the frame. The integrally cast guides shall have wedge blocks which are attached to the guide with silicon bronze fasteners. Gates having integrally cast frames, guides and wedge blocks shall be unacceptable. Both the integrally cast and bolt-on blocks shall have machined dove-tailed grooves in which the bronze wedge seats shall be driven and machined. Wedge seats which are bolted onto the wedge block or guide shall be unacceptable.

E. Wedges: Each gate shall be provided with a sufficient number of wedging devices to assure its compliance with the leakage requirements. Side wedges shall be designed to make full metal-to-metal contact with the wedge seats mounted on the guide wedge blocks. The wedges shall be solid cast bronze, machined on all contact surfaces, and keyed to the cast iron pads on the disc to prevent rotation and lateral motion. The wedges shall be attached to the disc with silicon bronze studs and nuts to lock them securely in position after they have been adjusted.
   1. Adjustable top and bottom wedges, where applicable, shall be attached to the disc either by tongue-and-groove arrangement with a signal fastener or by two fasteners. All mating and contact surfaces on the wedging devices shall be fully machined.

F. Seat Facings: The extruded seat facings shall be of a special shape to fill and permanently lock in the machined dovetail grooves on the frame and disc when pneumatically impacted into place. Attaching pins and screws shall not be acceptable. The installed seat facings shall be machined to a 63 micro-inch finish or better. Maximum clearance between seating faces shall not exceed 0.004 inch when the disc is in the fully closed position.

G. Stem
   1. The operating stem shall be of a size to safely withstand the stresses induced by normal operating forces without buckling or permanent distortion. The stem shall be designed to transmit in compression at least two (2) times the rated output of the floorstand or benchstand with a 40-pound effort on the crank or handwheel. The sluice gate manufacturer shall submit these calculations, if required by the Owner. The threaded portion of the stem shall have machined cut or rolled threads.
   2. Acme type. The contact surfaces of the threads shall have a maximum 16 micro-inch finish. Stems of more than one (1) section shall be jointed by stainless steel couplings threaded and keyed or bored and pinned to the stems. All threaded and keyed couplings of the same size shall be interchangeable. Manually operated, rising stem gates shall be provided with an adjustable bronze stop collar on the stem above the floorstand lift nut.

H. Stem Guides: Stem guides shall be cast iron, bronze brushed, mounted on cast iron brackets. They shall be adjustable in two (2) directions and shall be spaced at sufficient intervals to adequately support the stem. Stem guide spacing shall not exceed 10 feet, or an L/R ratio of 200.

I. Pipe Covers: Provide fabricated galvanized steel stem cover w/position indication on all rising stems.

J. Crank Operators: All gates shall have crank-operated floorstands or benchstands. Crank handle shall be removable. Crank operated type shall be geared and shall have a weatherproof housing with a solid bronze operating nut mounted on high-strength cast iron pedestals or base plates. The operating nut shall be internally threaded with threads corresponding to stem threading. Tapered roller or ball bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. All gears shall be constructed of steel and shall be accurately machine cut and of proper design to provide smooth operation and to support load conditions. Lubrication fittings shall be provided in the gear housing to permit lubrication of all gears and bearings. All reduction gear cases shall be precision machined and equipped with tapered rolled or needle bearings and sealed about all reduction shafts. Geared hoists shall have a 4:1 ratio. Each hoist shall be supplied with a 2-inch square operating nut, and a removable cast iron crank arm with revolving brass grip. Floorstands shall include a cast iron pedestal designed to position the input shaft approximately 36 inches above the operating floor. Where called for, the floorstand shall be mounted on a cast iron wall bracket which is specifically designed for the particular operator being used. An arrow with the word “Open” will be permanently attached or cast in the floorstand indicating the direction of rotation to open the gate.

K. All geared and handwheel floorstands shall operate with a maximum effort not to exceed 40 pounds on the crank or handwheel.

L. Painting - All submerged ferrous metal components (i.e., gate and frame, thimble, stem guides) shall be shop painted as follows: prepare surfaces to SSPC-SP-6; Primer - Amer Lock 400 by Ameron International Inc. Performance Coatings and Finishes Group, or approved equal, 5.0 mil dry film thickness; Top Coat - Amer Lock 400, or approved equal, 5.0 mil dry film thickness.

M. All exposed ferrous metal components (i.e., crank operator and floor stand) shall be shop painted as follows: prepare surfaces to SSPC-SP-3; Primer - Amer Lock 400, or approved equal, 5.0 mil dry film thickness, Top Coat - Amer Lock 450 HS, or approved equal, 2.0 mil dry film thickness

N. All bolts, studs and nuts required for setting the sluice gates, frames and operating stands shall be stainless steel and shall be supplied by the manufacturer.

1.3 EXECUTION

A. Provide and deliver cast iron thimble to be cast into wall as per manufacturer’s recommendations and as specified herein. Install the sluice gate with all appurtenances in strict conformance with manufacturer’s instructions.

END OF SECTION 35 22 26 00

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Task	Specification	Specification Description
35 22 59 00	22 05 23 00	General-Duty Valves for Plumbing Piping
35 22 59 00	22 05 23 00a	General-Duty Valves for HVAC Piping
35 22 59 00	35 22 26 00	Sluice Gates
35 22 63 00	35 22 26 00	Sluice Gates

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SECTION 35 24 00 00 - DREDGING

1.1 GENERAL

A. Description Of Work
1. This specification covers dredging. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definition
1. Hard material is defined as material requiring blasting or the use of special equipment for economical removal, and includes boulders or fragments too large to be removed in one piece by the dredge.

C. Submittals: Submit the following:
1. Shop Drawings: Indicate pipeline location and installation details. Submit drawings of surveys during progress of work by soundings or sweepings.
2. Protection plan: If blasting will be allowed, submit a plan for protection of surrounding structures, equipment, and vessels.

D. Material to be Removed
1. The material to be removed is silt and mud **OR** new material, **as directed**, applicable to the specific project.
a. Hard Material: Remove hard material. Blasting will not be permitted **OR** Blasting shall be performed only by experienced persons, **as directed**. Conduct operations in strict accordance with applicable regulations. Protect exposed structures from the effects of the blast in accordance with the protection plan

E. Artificial Obstructions
1. Except as indicated, the Owner has no knowledge of cables, pipes, or other artificial obstructions or of any wrecks, wreckage, or other material that would necessitate the use of explosives or the employment of additional equipment for economical removal. If actual conditions differ from those stated or shown, or both, an adjustment in contract price or time for completion, or both, will be made.
OR
The Owner has knowledge of debris such as, but not limited to, metal bands, pallets, pieces of broken cable, rope, fire hose, and broken piles. The Owner has no knowledge of existing wrecks, wreckage, or other material of such size or character as to require the use of explosives or special or additional plant for its economical removal. Prior to dredging, the Contractor shall rake the dredge areas and shall remove debris encountered. Debris removed from the dredged area shall be removed from the water. Disposal shall be the responsibility of the Contractor and disposal shall be outside the limits of government property. In case the actual conditions differ from those stated or shown, or both, an adjustment in contract price or time of completion, or both, will be made.

F. Side Slopes
1. Dredging on side slopes shall follow, as closely as practicable, the lines indicated or specified. An allowance will be made for dredging beyond the lines indicated or specified for side slopes. The allowance will be determined by projecting a line upwards, paralleling the project design side slopes, from the intersection of the overdepth dredging limit (at a point located vertically below the limit of dredging at the top of slope). The amount of material excavated from side slopes will be determined by either cross-sections or computer, or both.

G. Permit
1. The Contractor shall comply with conditions and requirements of State or Federal permits. the Owner will secure the permit for dredging and disposal of material as indicated. Make arrangements for disposal of excavated materials.

H. Environmental Protection Requirements
1. Provide and maintain during the life of the contract, environmental protective measures. Also, provide environmental protective measures required to correct conditions, such as oil spills or debris, that occur during the dredging operations. Comply with Federal, State, and local regulations pertaining to water, air, and noise pollution.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. Conduct Of Dredging Work
1. Order of Work Interference with Navigation: Minimize interference with the use of channels and passages. the Owner will direct the shifting or moving of dredges or the interruption of dredging operations to accommodate the movement of vessels and floating equipment, if necessary.
2. Compensation for Interruption of Operations: If dredging operations are interrupted due to the movement of vessels or floating equipment, an adjustment in the contract price or time for completion, or both, will be made as provided by the contract. the Owner will notify the Contractor 7 days prior to ship movements that will affect dredging operations.
3. Lights: Each night, between sunset and sunrise and during periods of restricted visibility, provide lights for floating plants, pipelines, ranges, and markers. Also, provide lights for buoys that could endanger or obstruct navigation. When night work is in progress, maintain lights from sunset to sunrise for the observation of dredging operations. Lighting shall conform to United States Coast Guard requirements for visibility and color.
4. Ranges, Gages, and Lines: Furnish, set, and maintain ranges, buoys, and markers needed to define the work and to facilitate inspection. Establish and maintain gages in locations observable from each part of the work so that the depth may be determined. Suspend dredging when the gages or ranges cannot be seen or followed. the Owner will furnish, upon request by the Contractor, survey lines, points, and elevations necessary for the setting of ranges, gages, and buoys.
5. Plant: Maintain the plant, scows, coamings, barges, pipelines, and associated equipment to meet the requirements of the work. Promptly repair leaks or breaks along pipelines. Remove dredged material placed due to leaks and breaks.
6. Disposal of Excavated Material: Provide for safe transportation and disposal of dredged materials. Transport and dispose of dredged material in the area designated for disposal of dredged material.
OR
The Contractor may, at his option, dispose of dredge material at an approved disposal area. The deposit of dredged materials in unauthorized places is forbidden. Comply with rules and regulations of local port and harbor governing authorities.
a. Method of Disposal: Deposit dredged material by the hydraulic process **OR** hopper dredge **OR** self-dumping scow or barge, **as directed**. Pipeline for hydraulic dredging shall discharge into the disposal area.
b. Disposal in Indicated Fill Areas: In depositing excavated material for fill, uniformly grade and allow for shrinkage. Provide and maintain necessary bulkheads, dikes, ditches, weirs, spillways, and other construction necessary to confine and retain the fill in the dredge fill area.
c. Operation of Sluiceways: Sluiceways on the disposal area levees will be operated and maintained by the Owner. The Contractor will be relieved of operations thereof.

d. Submerged Pipeline: If a leak occurs in the discharge pipeline, immediately discontinue using the line until leaks are repaired. Remove material placed due to leaks or breaks.

7. Navigation Warnings: Furnish and maintain navigation warning signs along the pipeline.
8. Method of Communication: Provide a system of communication between the dredge crew and the crew at the disposal area. A portable two-way radio is acceptable.
9. Salvaged Material: Anchors, chains, firearms, and other articles of value, which are brought to the surface during dredging operations, shall remain or become the property of the Owner and shall be deposited on shore at a convenient location near the site of the work, as directed.
10. Safety of Structures: The prosecution of work shall ensure the stability of piers, bulkheads, and other structures lying on or adjacent to the site of the work, insofar as structures may be jeopardized by dredging operations. Repair damage resulting from dredging operations, insofar as such damage may be caused by variation in locations or depth of dredging, or both, from that indicated or permitted under the contract.
11. Plant Removal: Upon completion of the work, promptly remove plant, including ranges, buoys, piles, and other markers or obstructions.

B. Measurement

1. Contractor shall take soundings before and after dredging.
   a. Method of Measurement: The material removed will be measured by means of soundings taken before and after dredging. The drawings represent existing conditions based on current available information, but will be verified and corrected, if necessary, by soundings taken before dredging in each locality. Soundings will be taken by lead line or 200 kHz sonic methods, or both, as determined by the Owner; results of soundings by either or both methods will be the basis for payment. Areas sounded more than 30 days prior to dredging will be re-sounded when requested by the Contractor. The Contractor has the option of being present when such soundings are made.
   b. Surveys During Progress of Work: Contract depth will be determined by soundings or sweepings taken behind the dredge as work progresses. The Contractor shall take progress soundings or sweepings.

C. Final Examination And Acceptance

1. As soon as practicable after the completion of areas, which in the opinion of the Owner, will not be affected by further dredging operations, each area will be examined by the Owner by sounding or sweeping, or both. Remove shoals and lumps by dragging the bottom or by dredging. However, if the bottom is soft and the shoal areas form no material obstruction to navigation, removal may be waived at the discretion of the Owner. The Contractor will be notified when soundings or sweepings are to be made and will be permitted to accompany the sounding or sweeping party and to inspect the data and methods used in preparing the final estimate. When areas are found to be in a satisfactory condition, the work therein will be accepted as complete. Final estimates will be subject to deductions or correction of deductions previously made because of excessive overdepth, dredging outside or authorized areas, or disposal of material in an unauthorized manner.

END OF SECTION 35 24 00 00

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Task	Specification	Specification Description
35 24 13 00	35 24 00 00	Dredging
35 24 13 13	35 24 00 00	Dredging
35 24 23 00	35 24 00 00	Dredging
35 24 26 00	35 24 00 00	Dredging

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SECTION 35 51 13 00 - FLOATING PIERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of boat barrier float system. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
2. The Contractor shall install both a temporary and a permanent boat barrier float system. The temporary system shall remain the property of the Owner.

1.2 PRODUCTS

A. Temporary System
1. Spar Buoys: ABS plastic exterior, urethane foam filled, 5 inch diameter, 76 inch long, with hazard warning symbol and “DANGER” message.
2. Can Buoys: ABS plastic exterior, urethane foam filled, 14 inch can diameter, 30 inch can height, 28 inch collar diameter, 12 inch collar height, internal ballast, bottom attachment, with hazard warning symbol and “DANGER” message and approved J.A. McDermott Type BUNY, or approved equal, light assembly. Light shall be 60 flashes per minute, medium intensity with clear polycarbonate lens. Also to be provided are: one spare light assembly, 4 sets of batteries and 6 spare bulbs.
3. Buoys are to be anchored using 1/4-inch galvanized chain with galvanized connecting links and galvanized anchor shackles attached to concrete anchors.
4. Barrier rope to be 3/8 inch diameter white polypropylene rope with 2-1/2 inch diameter, 5 inch long red and white rope floats with float clips.

B. Permanent System
1. Two 16 inch diameter, urethane foam filled, orange polyethylene spheres with 1/2-inch diameter steel rod through the float with galvanized eye nut swivels on both ends.
2. Three 18 inch diameter, 30 inch long, urethane foam filled, white polyethylene floats with 1 inch diameter Schedule 40 galvanized steel pipe through the float.
3. Barrier cable to be 5/16 inch diameter, yellow polypropylene coated, galvanized cable, “Permaflex,“ or approved equal
4. The spherical floats will be anchored to the bottom using 1/4-inch galvanized chain with galvanized anchor shackles attached to concrete anchors.

1.3 EXECUTION

A. Both systems shall be installed per the manufacturer’s recommendations.

END OF SECTION 35 51 13 00

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SECTION 35 51 13 23 - STONE GROINS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor and materials for installation of temporary rock groins.

1.2 PRODUCT - (Not Used)

1.3 EXECUTION

A. The Contractor shall temporarily place a heavy stone fill rock groin in the river as directed by the Owner. Construction of the stone groin shall be completed before any excavation or permanent stone fill work is started. After excavation and stone fill work is completed to the elevations as directed by the Owner, the stone shall be removed from the groin and incorporated into the final stone fill section. Removal of the stone groin shall begin at the down river end and proceed up river. The rock groin shall overlap completed stone fill sections by 15 ft. at all times.

END OF SECTION 35 51 13 23

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SECTION 35 51 13 23a - STOP LOGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor, material and equipment for the installation of timber stop logs.

1.2 PRODUCTS

A. Stoplog tools will be provided as required to meet project requirements. Handle shall be 1-1/2 in. (38 mm) diameter ash handle, 10 ft. (3 m) long, equal to No. 75188. Tools shall be capable of lifting stop logs out of the structure.

1.3 EXECUTION

A. Stop logs shall be constructed from seasoned White Oak. Stop logs shall be dressed to the size as required to meet project requirements with a maximum moisture content of 19% at time of dressing. The timbers shall be #1 or better, as determined by visual grading in conformance with the latest standards of the National Forest Products Association. Bolts, nuts, flat washers and lock washers shall be galvanized steel. All stop logs shall be field installed and removed to demonstrate acceptability. Size and number of stop logs shall be as required to meet project requirements.

END OF SECTION 35 51 13 23a

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Task	Specification	Specification Description
35 51 13 23	31 24 13 00	Levee Closure
35 51 13 23	35 51 13 00	Floating Piers
35 51 13 29	35 24 00 00	Dredging
35 51 13 29	35 51 13 23	Stone Groins
35 51 13 29	31 24 13 00	Levee Closure
35 51 13 29	35 51 13 00	Floating Piers
35 51 13 29	35 51 13 23a	Stop Logs
35 52 13 00	35 24 00 00	Dredging
35 52 13 00	35 51 13 23	Stone Groins
35 52 13 00	31 24 13 00	Levee Closure
35 52 13 00	35 51 13 23a	Stop Logs

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Task	Specification	Specification Description
40 05 19 00	33 42 00 00	Stormwater Conveyance
40 05 23 23	07 63 00 00	Common Work Results for Fire Suppression
40 05 23 23	22 05 00 00	Common Work Results for Plumbing
40 05 23 23	07 63 00 00a	Common Work Results for HVAC
40 05 23 23	33 11 13 00a	Potable Water Supply Wells
40 05 23 23	33 31 00 00	Site Sanitary Sewerage Piping
40 05 23 23	33 32 00 00	Site Packaged Sewage Pumping Stations
40 05 41 00	07 63 00 00	Common Work Results for Fire Suppression
40 05 41 00	22 05 00 00	Common Work Results for Plumbing
40 05 41 00	07 63 00 00a	Common Work Results for HVAC

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SECTION 41 22 23 00 - HOISTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monorails with air motor powered hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions
1. The Contractor shall be responsible for the coordination of his work with the work of all trades involved and as it relates to the building structure. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the the Owner of any discrepancy before order to the monorail manufacturer is finalized.

C. Submittals
1. Shop Drawings
2. Design Data
3. Test Reports
4. Certificates
5. Operation and Maintenance Data

D. Quality Assurance
1. Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, air system details, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Certificates: Submit certification of minimum wire rope breaking strength for each hoist. Where applicable, submit factory certification of the load chain rated capacity.
3. Design Data: Submit design calculations verifying the size of structural members, structural supports (fittings, rods, brackets, and components), and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

E. Maintenance: Submit data package for the entire monorail system.

1.2 PRODUCTS

A. Fabrication And Construction
1. The hoist and trolley shall conform to ANSI/ASME HST-5M or ANSI/ASME HST-6M, **2 OR 3 OR** 5, **as directed**, ton (2 **OR** 3 **OR** 5, **as directed**, metric ton), for general service **OR** protected indoor **OR** all weather outdoor, **as directed**, (0 degrees to 100 degrees F (-18 to 38 degrees C)) working conditions. 2 ton (2 metric ton) design criteria shall apply to hoists of 2 ton (2 metric ton), or less, rated lifting capacity. Hoists of 2, 3, or 5 ton (2, 3, or 5 metric ton) rated capacity, shall be equipped with an automatic mechanical load lowering brake.
2. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
3. Hook Lift and Speed: Shall be the manufacturer's standard within the limits specified in ANSI/ASME HST-5M or ANSI/ASME HST-6M. The hook lift shall be at its highest point a minimum height as required to meet project requirements above the finished floor and at its lowest point a minimum as required to meet project requirements below the finished floor.

OR

B. Fabrication And Construction

1. The 1/4 **OR** 1/2 **OR** 1, **as directed**, ton (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) hoist and trolley shall meet the design requirements specified in ANSI/ASME HST-5M or ANSI/ASME HST-6M for the 2 ton (2 metric ton) hoist trolley.
2. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
3. Hook Lift and Speed: For 1/4 **OR** 1/2 **OR** 1, **as directed**, ton (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) hoist(s), the hook lift shall be at its highest point a minimum height as required to meet project requirements above the finished floor and at its lowest point a maximum **OR** minimum, **as directed**, as required to meet project requirements above **OR** below, **as directed**, the finished floor. The hook lift and speed limits for 1/4 **OR** 1/2, **OR** 1 ton, **as directed**, (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) rated capacity hoists shall be within the limits shown in the following table.

Standardized hoist lift ranges and rated lifting speed ranges for 1/4, 1/2, and 1 metric ton rated capacity

Rated load Capacity (metric tons)	Hoist lift range (meter)	Hoist lifting speed range (mm/s) Low	High
1/4	3 to 15	120	350
1/2	3 to 12	80	250
1	3 to 10	40	225

Standardized hoist lift ranges and rated lifting speed ranges for 1/4-, 1/2-, and 1-ton rated capacity

Rated load capacity (tons)	Hoist lift range (feet)	Hoist lifting speed range (feet per minute) Low	High
1/4	10 to 50	24	70
1/2	10 to 40	16	50
1	10 to 30	8	45

4. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.
5. Hoist Wire Rope: Rope lengths shall be sufficient to maintain a minimum of two full wraps of rope at the dead end(s) of the drum, with the block in its lowest indicated position.
6. Hoist Chain: Chain hoists of 10 foot (3 m) lift or more shall be equipped with a load chain bucket.
7. Hoist Limit Switch: Hoists shall be equipped with upper and lower hoist limit switches/devices.
8. Control Pendant: Shall extend as required to meet project requirements below the underside of the track beam.
9. Trolley: Shall have a manual **OR** geared manual **OR** air motor powered, **as directed**, drive and shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.

C. Monorail Track Beam System
1. Shall conform to MMA MH27.1, for powered hoists. The maximum allowable deflection shall not exceed 1/600 of the unsupported span, with the hoist(s) at rated load(s) and at any location(s). The track beam system shall have trolley stops at all open end locations. The stops shall be designed to retain the hoist on the track. Wheel stops shall interface with the trolley wheel treads on both sides of the track web simultaneously and shall not interface with the trolley wheel flanges. The air supply valve specified shall be of the quick shutoff type, readily accessible from the floor, and located within proximity to the monorail system.
2. Color of Finished Equipment: Shall be the manufacturer's standard brilliant yellow.
3. Identification Plates: The manufacturer shall furnish and install identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

1.3 EXECUTION

A. Erection And Installation
1. The Contractor shall erect and install the hoist and monorail system in accordance with of MMA MH27.1. The monorail supplier shall provide supervisory erection services.

B. Field Inspection And Tests
1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and detail drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.
2. Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be tested in operation as specified, carrying 125 percent of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. The air equipment will not necessarily operate at rated speed with a 125 percent overload. For hoists that incorporate mechanical load brakes, the mechanical load brake shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and other apparatus as necessary to conduct field tests on hoist and monorail. The test and final adjustments of the equipment shall be under the supervision of the the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 41 22 23 00

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SECTION 41 22 23 00a - SPECIALTY HOISTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material handling hoists. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Electric Chain Hoists
1. Hoist motors shall be H4 duty classification. Class F insulation shall be used in hoist motor for 30 minute operation. Load chain shall be grade 80 alloy, case hardened and zinc plated sized for the intended load. Hoists shall employ AC motor brakes employing single or multiple all-steel disks. Controls shall be hand-held, low voltage electrical, with emergency shut off and enclosed in NEMA 3R rated weatherproof enclosure. Hoist shall include fail safe limit switches in the hoist enclosure. Hoist shall meet requirements of ANSI B30.16 standard. Load hook shall be heavy-duty drop forged with safety latch. Hoist shall have swivel top and bottom hooks.

B. Manual Chain Hoists
1. Load capacity of hoist shall be as specified. Load chain shall be grade 80 alloy, case hardened and zinc plated sized for the intended load. Load hook shall be heavy-duty drop forged with safety latch. Hoist mechanism shall be double pawl ratchet system with Weston type brake using a non-asbestos friction disk. Hoist shall have swivel top and bottom hooks. Hoist shall require between 50 and 80 pounds effort to move load.

C. Electric Wire Rope Hoists
1. Hoist motors shall be H4 duty classification. Class F insulation shall be used in hoist motor for 30 minute operation. Lift range shall be between 20 and 150 feet. Lifting cable shall be pre-formed wire rope, of hoisting service construction, made of extra improved steel (XIP) with an independent wire rope center. Load hook shall be heavy-duty drop forged with safety latch. Hoist shall have swivel top and bottom hooks. Controls shall be hand held, low voltage electrical, with emergency shut off and enclosed in NEMA 3R rated weatherproof enclosure. Hoist shall include fail-safe limit switches in the hoist enclosure. Hoist shall meet requirements of ANSI B30.16 standard.

1.3 EXECUTION

A. Installation
1. The Contractor shall complete the assembly of any equipment furnished partially assembled and place the items in position as directed. The hoists shall be assembled and securely bolted in position, hoisting chain or wire rope installed, and the hoist made ready for regular operation. The Contractor shall furnish all miscellaneous hardware items required to complete the installation of all equipment and components. Equipment shall be primed and finish painted with a suitable corrosion-resistant paint on all parts and components not made of corrosion-resistant materials or otherwise protected.

END OF SECTION 41 22 23 00a

SECTION 41 22 23 00b - MONORAILS WITH ELECTRIC POWERED HOISTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monorails with electric powered hoists. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. System Description
1. Provide a monorail system with electric powered hoist(s) and plain type (hand operated) **OR** hand chain operated **OR** electric powered, **as directed**, trolley(s) complete, tested and ready for operation. Monorails, hoist(s), trolley(s), equipment, materials, installation, examination, inspection, and workmanship shall be in accordance with the applicable requirements of NFPA 70, ASME/ANSI B30.11, ASME/ANSI B30.16, ASME HST-1M, ANSI/ASME HST-4M, and MMA MH27.1, with modifications specified herein. Reference in these publications to the "authority having jurisdiction" shall be interpreted to mean the "the Owner."

C. Submittals
1. Shop Drawings: Monorail system
2. Product Data: Monorail track system including switches, suspension system and other components; Electric wire rope hoist; Electric chain hoist; Trolley; Pendant pushbutton station; Electrification.
3. Design Data: Load and sizing calculations.
4. Test Reports
5. Certificates
6. Operation and Maintenance Data

D. Delivery, Storage, and Handling
1. Delivery and Storage: Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, including subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. When special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.
2. Handling: Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to the Owner.

E. Quality Assurance
1. Certificates: Overload Test Certificate: Submit a statement that the monorail system can be periodically load tested to 125 percent (plus 5 minus 0) of rated load.
2. Drawings: Monorail System: Show the general arrangement of all components, clearances and principal dimensions, assemblies of hoist, trolley, track, track suspension system, and electrical schematic drawings.
3. Design Data: Load and Sizing Calculations: Submit calculations verifying the sizing of any track, track suspension device and additional supports which are not the monorail system manufacturer's standard cataloged product.

1.2 PRODUCTS

A. Overhead Monorail System: Provide overhead monorail system conforming to MMA MH27.1, Class C, for indoor **OR** outdoor, **as directed**, service, with an electric wire rope or chain hoist mounted on a movable trolley. Trolley shall be plain type (hand operated) **OR** hand chain operated **OR** motor operated, **as directed**. Monorail system shall operate on AC voltage as required to meet project requirements, 60 Hz, single **OR** three, **as directed**, phase power source.

1. Capacity: The monorail system shall have a minimum rated capacity as required to meet project requirements. Mark the hoist capacity in pounds (kg) on both sides of the hoist or load block.
2. Speeds: The hoist shall have two operating speeds, **unless directed otherwise,** and shall be capable of hoisting and lowering the rated load at a high speed of 20 feet per minute (fpm) (100 mm/s). The trolley shall have two operating speeds, **unless directed otherwise,** and shall be capable of moving the rated load at a high speed of 50 fpm **OR** 100 fpm, **as directed**, (250 mm/s **OR** 500 mm/s, **as directed**,). Low speed(s) shall be one quarter to one third of high speed(s). Actual speed(s) shall be within plus or minus 15 percent of those specified.
3. Material Limitations: Shafts, keys, couplings, sprockets, and chains shall be steel. All gears shall be steel except for worm gears, which shall be bronze or steel. Cast iron and aluminum used to support components of the hoist power transmission train shall be ductile.
4. Safety: Comply with the mandatory and advisory safety requirements of ASME/ANSI B30.11, ASME/ANSI B30.16, and 29 CFR 1910.179.

B. Monorail Track System: MMA MH27.1. Track beams shall be patented track sections fabricated by a manufacturer regularly engaged in production of this type of beam.

1. Track Suspension System: Monorail suspension shall be flexible **OR** rigid, **as directed**, type. Make bolted connections to supporting structure, excluding hanger rods, with ASTM A 325/A 325M bolts, ASTM A 563/A 563M nuts, and ASTM F 959/F 959M load indicator washers. ASTM A 325/A 325M bolts shall be fully pre-tensioned in accordance with AISC S329. Support monorail track system from the structural members shown. Provide additional supports as required to carry monorail track system loads to the structural members shown. Materials for additional supports shall conform to the material requirements contained in Division 5 Section “Structural Steel Framing".

C. Electric Wire Rope Hoist: ANSI/ASME HST-4M, Class H3, except as modified herein. Hoist shall be double reeved, **unless directed otherwise**.

1. Hoisting Ropes: FS RR-W-410, improved or extra improved plow steel, regular lay, uncoated, 6 by 37 class construction, with an independent wire rope core. Provide proof of wire rope breaking strength test report.
2. Sheaves: Sheaves shall be steel or ductile cast iron. Pitch diameter of running sheaves shall not be less than 16 times the rope diameter. Pitch diameter of non running sheaves shall not be less than 12 times the rope diameter.
3. Drum: Drum shall be steel or ductile cast iron. Pitch diameter of the drum shall not be less than 18 times the rope diameter. Not less than two dead wraps of the hoisting rope shall remain on each anchorage when the hook is in its extreme low position.

D. Electric Chain Hoist: ASME HST-1M, Class H3, except as modified herein. Provide load chain proof test.

E. Trolley: Trolley shall meet all applicable requirements of MMA MH27.1, ASME HST-1M and ANSI/ASME HST-4M. Trolley shall have elastomeric bumpers to engage runway stops.

F. Motors: NEMA MG 1. Hoist motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Trolley motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Motor insulation shall be Class B minimum. Provide totally enclosed non-ventilated (TENV) motor enclosures. Maximum motor speed shall not exceed 1800 RPM.

G. Controls: Provide single **OR** two, **as directed**, speed magnetic control for the hoist. Provide single **OR** two, **as directed**, speed magnetic controls for the trolley. Provide reduced voltage starting, acceleration and deceleration for the trolley drive.

H. Limit Switches: Provide upper and lower limit switches which de-energize the hoist motor.

I. Brakes: Provide hoist with an electro-mechanical holding brake and a mechanical load brake, each capable of holding 130 percent of the rated hoist capacity. Hoist holding brake shall be capable of being released to test the load brake. Provide trolley with an electro-mechanical brake. Provide trolley brake with a minimum torque rating of 100 percent (for outdoor monorails) or 50 percent (for indoor monorails) of the drive motor rated torque. Trolley brake torque shall be adjustable down to 85 percent of its torque rating.

J. Load Block And Hook: Construct load blocks of steel. Provide forged steel, swivel type hook, with hook nut keyed to hook shank by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or other similar easily removable securing device. Hook throat opening shall not be less than as required to meet project requirements. Provide hook with spring loaded steel safety latch for closing the hook throat opening. The hook and hook nut shall be unpainted. Permanently mark hook and hook nut with an identification number.
   1. Hook and Hook Nut Magnetic Particle Inspection: Magnetic particle inspect the hook and nut over the entire area in accordance with ASTM A 275/A 275M. Acceptance standard shall be no defects. A defect is defined as a linear indication that is greater than 1/8 inch (3 mm) long whose length is equal to or greater than three times it width.

K. Bearings: All bearings except those subject to a small rocker motion shall be anti-friction type. Bearings not considered lifetime lubricated by the manufacturer shall be provided with a means for lubrication.

L. Pendant Pushbutton Station: Hoist and trolley, **unless directed otherwise,** shall be controlled from a pendant pushbutton station. Arrange pushbuttons in accordance with ASME/ANSI B30.11recommendations. Locate station 4 feet (1.2 m) above the finished floor

M. Electrification: Runway electrification shall be of the flat festooned type **OR** enclosed safety bar type, **as directed**, with four continuous copper conductors. Provide electrical work for the monorail system in accordance with NFPA 70.

N. Identification Plates: Provide identification plates of noncorrosive metal with clearly legible permanent lettering giving the manufacturer's name, model number, capacity in pounds, and other essential information or identification.

O. Painting System: Painting shall be manufacturers standard. Provide a primer and a finish coat. For outdoor monorail systems, blast clean all components prior to painting and prime with inorganic zinc type primer; finish coat shall be an epoxy formulated for marine environments. Paint coats shall be smooth and even, free of runs, sags, orange peel, or other defects.

1.3 EXECUTION:

A. Erection And Installation: Erect and install the monorail system, complete in accordance with the approved submittals and in condition to perform the operational and acceptance tests.

B. Erection Services: Provide supervisory erection services from the monorail system manufacturer.

C. Field Quality Control
   1. Post-Erection Inspection: After erection, the Contractor and the the Owner shall jointly inspect the monorail and hoist systems and components to determine compliance with specifications and

approved submittals. The Contractor shall notify the the Owner 3 days before the inspection. Provide a report of the inspection indicating the monorail system is considered ready for operational tests

2. Operational Tests: After erection and inspection, test the hoist, and trolley as specified herein. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacturer, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the monorail system is operational. The Contractor shall furnish loads for testing, operating personnel, instruments, and all other necessary apparatus. The the Owner will furnish loads for testing; the Contractor shall receive and transport the loads from a location not more than 100 miles (161 km) from the job site and shall return them to that location after the tests have been completed.
3. Test Data: Record test data on appropriate test record forms suitable for retention for the life of the monorail system. Record operating and startup current measurements for electrical equipment (motors and coils) using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Record hoist and trolley speeds during each test cycle.
4. Hook Test: Measure hook for hook throat spread before and after load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch (0.4 mm)). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening by more than 5 percent from the base measurement shall be cause for rejection.
5. No-Load Test
    a. Hoist: Raise the load hook the full operating lift distance and verify satisfactory operation of hoist, upper limit switch, lower limit switch, and the hoisting and lowering speeds. Operate the hoist at low and high speed in both directions.
    b. Trolley: Operate trolley assembly the full length of the monorail in both directions. Operate trolley at low and high speed in each direction. Verify satisfactory operation and verify trolley speed. Operate all rail switches.
6. Load Test: 125 Percent (plus 5 percent minus 0) of rated capacity
    a. Hoist Static Test: Raise test load approximately one foot above the floor and hold for 10 minutes. Observe load lowering that may occur which will indicate malfunction of hoisting component or brake. Lower the test load to the floor until the hoist line is slack.
    b. Hoist Dynamic Test: Raise the test load to approximately 5 feet (1.5 m) above the floor using both speed points in the process. Lower the load back to the floor using both speed points. Stop the test load at least once while lowering at high speed and observe proper brake operation. Wait 5 minutes, then repeat the above cycle.
    c. Load Brake Test: Raise test load approximately 5 feet (1.5 m). With the hoist controller in the neutral position, release the holding brake. The load brake should hold the test load. Again with the holding brake in the released position, start the test load down at low speed and return the controller to off position as the test load lowers. The load brake should prevent the test load from accelerating. NOTE: It is not necessary for the load brake to halt the downward motion of the test load.
    d. Loss of Power Test: Raise the test load approximately 3 feet (1 m) and while lowering test load at low speed, cut main power to hoist. Load should stop.
    e. Trolley Test: With test load hoisted to a height of one foot (300 mm) above the floor, operate trolley the full distance of the monorail in both directions using both speed points in the process. Observe for any malfunctioning of the trolley assembly and monorail system. Operate all rail switches.
    f. Rated Load Speed Test: With the hoist loaded to rated capacity, raise and lower the load verifying that the hoisting and lowering speeds are provided as specified. With the hoist loaded to rated capacity, operate trolley along the monorail beam verifying that the trolley

speed is provided as specified. Further, verify that the trolley stops in each direction within a distance (in feet) equal to 10 percent of rated capacity high speed (in feet per minute) when initially travelling at high speed and carrying the rated capacity load. Record voltage, amperage, hoisting and lowering speeds, trolley travel speed, and motor speed for each motor.

END OF SECTION 41 22 23 00b

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SECTION 41 22 23 00c - MONORAILS WITH MANUAL HOIST

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monorails with manual hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions:
1. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the Owner of any discrepancy before the order to the monorail manufacturer is finalized.

C. Submittals
1. Shop Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Design Data: Structural design calculations.
3. Test Reports
   a. Hook and hook nut magnetic-particle tests.
   b. Monorail system load tests
4. Certificates: Manual hoist load chain
5. Operation and Maintenance Data
   a. Track beam system
   b. Hoist and trolley

D. Quality Assurance
1. Certifications: Submit factory certification of load chain rated capacity.
2. Design Data: Submit design calculations verifying the size of structural members, structural support fittings, rods, brackets, components, and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

1.2 PRODUCTS

A. Fabrication And Construction: Provide manual hoist and trolley, ANSI/ASME HST-2M, ANSI/ASME HST-3M, trolley suspension. Trolley and wheels shall be suitable for operation on the steel monorail track beam provided, and shall have not less than four wheels.
1. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
2. Hook Lift: Shall be the manufacturer's standard. The hoist lift shall be at its highest point a minimum of 8 feet (2400 mm) above the finished floor and at its lowest point a minimum of 2 feet (600 mm) below the finished floor.
3. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle

inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.

4. Trolley: Shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.
5. Load Chain: High strength steel links, flexible; minimum safety factor of 5 to 1 based on ratio of minimum chain breaking load to the calculated load on the chain when the hoist is assumed loaded to rated capacity. Certification from hoist manufacturer of provided chain's breaking strength shall be submitted to the Owner and approved prior to final acceptance of hoist. Do not paint or coat the load chain.
6. Load Hooks and Load Hook Components
    a. Hook: Forged steel; complete with spring-loaded steel throat opening safety device. The hook shall be carried on suitably sealed or shielded anti-friction thrust bearings and shall swivel freely through 360 degrees rotation with full load without twisting chain.
        1) Disassembly. Hook and hook nut shall be capable of complete disassembly that enables access to all surfaces of the hook, including shank and hook nut for inspection purposes. Provision shall be made for the hook nut, or other hook-to-block fastener, to be keyed to hook shank by means of a set screw or similar, easily removable, securing device.
        2) Hook Non-Destructive Test. Each hook, including shank and hook nut, shall be inspected over the entire surface areas by magnetic particle inspection. If hook nut is not used, any device that functions the same as the hook nut shall be inspected by magnetic particle inspection.
            a) Procedure: Magnetic particle inspection shall be conducted in accordance with ASTM A 275/A 275M. This inspection shall be conducted at the factory of the hook manufacturer or hoist manufacturer. Alternately, a recognized independent testing lab may conduct the inspections if equipped and competent to perform such a service, and if approved by the the Owner.
            b) Acceptance Criteria: Defects found on the hook or hook nut shall result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear or non-linear indication for which the largest dimension is greater than 1/8 inch (3 mm). Weld repairs for defects on hook or hook nut will not be permitted.
            c) Test Report: A test report of the magnetic particle inspection of each hook and hook nut provided shall be submitted to and approved by the the Owner prior to final acceptance of hoist installation. Test reports shall be certified by the testing organization.

B. Monorail Track Beam System: Comply with MMA MH27.1 except as modified and supplemented herein.
    1. Patented Track: Provide specially designed trackage, e.g., patented track beam, curves, and switches constructed from welded steel components. The lower flange of the track section shall have flat wheel treads; minimum lower flange width of 3.25 inches (80 mm); chemical composition of 0.45 to 0.60 percent carbon content, 0.60 to 1.1 percent manganese content; and wheel treads shall be hardened to a minimum Brinell Hardness Number of 225. Upper flange and web of the track section shall be steel, continuously welded together or provided as one monolithic piece.
    2. Track Suspension: Provide means of suspending the monorail track system, including curves and switches from the structural supports. The suspension system shall be the sole responsibility of the track supplier; however, design shall be subject to the requirements specified herein.
        a. Cataloged Products: If possible, provide track manufacturer's standard cataloged devices for connection of the track to the indicated supporting structures. If track manufacturer's cataloged devices are not provided for this suspension system, complete shop drawings and calculations for the custom suspension device shall be submitted for review and approval by the the Owner. Track suspension devices which are not the track

manufacturer's cataloged products shall meet the additional requirements specified in YYYY99YYYY.

b. Design: The suspension system shall be designed and constructed to ensure no impairment of the strength of track or the structural support. A hanger or suspension shall be located at each rack splice joint. Provide bracing to hold track sections in rigid alignment at all joints.

c. Suspension of Curves and Switches: Provide steel framing (structural supports), in addition to that indicated, as required by monorail curve and switch manufacturer to support curves and switches. The additional steel framing shall be the sole responsibility of the monorail supplier. Submit shop drawings and framing design calculations to the the Owner for approval.

d. Sway Bracing: Where the track is suspended from hanger rods, track shall be braced laterally and longitudinally to prevent sway.

e. Lock Nuts: Where the track is suspended from hanger rods, lock nuts or other means shall be provided to prevent the nuts from backing off the rods.

f. Multiple Suspension Devices: Where more than one suspension device attached to the track at a single point, the suspension devices shall be provided so that the loads shall be induced in each in proportion to the device's size.

3. Identification Plates: Provide identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

C. Painting Of System: Provide manufacturer's standard painting or shop painting of components specified in this section; comply with the requirements specified in YYYY578YYYY. Do not paint, coat, or galvanize load chain, load, hook nut, or load chain sheave.

1.3 EXECUTION

A. Erection And Installation: The Contractor shall erect and install the hoist trolley and monorail system in accordance with manufacturers written instructions, MMA MH27.1, and the contract drawings. The monorail supplier shall provide supervisory erection services. Welding new sections of monorail track to existing shall conform to AWS D1.1.

B. Field Inspection And Tests

1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and shop drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.

2. Operational Inspection and Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be given the rated load test specified in ASME/ANSI B30.11, carrying 125 percent (plus 5 percent, minus 0 percent) of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. Hoists shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and all other necessary apparatus at no additional cost to the Owner. The test and final adjustments of the equipment will be under the supervision of the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 41 22 23 00c

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Task	Specification	Specification Description
41 22 23 13	41 22 23 00	Hoists
41 22 23 13	41 22 23 00a	Specialty Hoists
41 22 23 13	41 22 23 00b	Monorails With Electric Powered Hoists
41 22 23 13	41 22 23 00c	Monorails With Manual Hoist

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SECTION 43 11 43 00 - VACUUM EQUIPMENT FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Medical vacuum packaged system.
2. Vacuum pump packaged system - liquid ring.
3. Vacuum pump packaged system - rotary screw, oil sealed.
4. Vacuum pump packaged system - rotary claw, dry.
5. Vacuum pump packaged system - rotary vane, oil less.
6. Vacuum pump packaged system - rotary vane, oil sealed.
7. Turbine exhausters.
8. Vacuum pump packaged system - diaphragm.
9. Dental vacuum packaged system.
10. Dental vacuum system control panels.

1.2 DEFINITIONS

A. Actual Air: Air delivered at vacuum producer inlet. Flow rate is air measured in **acfm (actual L/s)**.

B. HVE: High-volume oral evacuation for dental applications in healthcare facilities.

C. Laboratory Vacuum Equipment: Vacuum producers and accessories for laboratory facilities.

D. Medical Vacuum Equipment: Includes [**medical-surgical**][**WAGD**][**dental**][**and**][**HVE**] vacuum producers and accessories for healthcare facilities.

E. Standard Air: Free air at **68 deg F (20 deg C)** and **1 atmosphere (29.92 in. Hg)** before compression or expansion and measured in **scfm (standard L/s)**.

F. WAGD: Waste anesthetic gas disposal for medical-surgical applications in healthcare facilities.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Medical vacuum packaged system.
2. Vacuum pump packaged system - liquid ring.
3. Vacuum pump packaged system - rotary screw, oil sealed.
4. Vacuum pump packaged system - rotary claw, dry.
5. Vacuum pump packaged system - rotary vane, oil less.
6. Vacuum pump packaged system - rotary vane, oil sealed.
7. Turbine exhausters.
8. Vacuum pump packaged system - diaphragm.
9. Dental vacuum packaged system.
10. Dental vacuum system control panels.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Diagrams for power, signal, and control wiring.

D. Delegated Design Submittals:

1. Detail fabrication and assembly of supports.
2. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases, indicated to comply with performance requirements and design criteria, including analysis data[**signed and sealed by the qualified professional engineer responsible for their preparation**].

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates for vacuum producers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Qualification Statements: For [**Installer**][**and**][**testing agency**].

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For vacuum equipment.

1. Indicate actual installed items by marking the submittals with an arrow or box.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[**, from the same production run,**] to Owner that match products installed and that are packaged with protective covering for storage and identified with labels

describing contents.

1. Belts: [**One**][**Two**]<**Insert number**> for each belt-driven vacuum producer.

1.7 FIELD CONDITIONS

A. Interruption of Existing Vacuum Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with the requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of vacuum service.
2. Do not proceed with interruption of vacuum service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.10 QUALITY ASSURANCE

A. Installer Qualifications:

1. Laboratory Vacuum Equipment for Laboratory Facilities: An employer of workers trained and approved by manufacturer.
2. Medical Vacuum Equipment for Healthcare Facilities: Qualify installers in accordance with ASSE 6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum equipment testing indicated, that is[**a member of the Medical Gas Professional Healthcare Organization or is**] an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel in accordance with ASSE 6020 for inspectors and ASSE 6030 for verifiers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 99, "Health Care Facilities Code," for vacuum equipment and accessories for medical and dental vacuum systems.

C. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vacuum equipment mounting.

E. Seismic Performance: Vacuum equipment to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.[**See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**]

1. The term "withstand" means the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 GENERAL REQUIREMENTS FOR VACUUM SYSTEMS

A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receivers.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120 V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Automatic control switches to [**alternate lead-lag vacuum pumps for duplex**][**and**][**sequence lead-lag vacuum pumps for three or more**] vacuum pumps.
7. Instrumentation: Include vacuum pump inlet and receiver vacuum gauges, hour meter, vacuum pump discharge-air and coolant temperature gauges, and control transformer.
8. Alarm Signal Devices: For connection to alarm system to indicate when backup vacuum pump is operating.
9. Provide 65k AIC SCCR rating.

C. Receivers: Steel tank constructed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols.

1. Interior Finish: Corrosion-resistant coating.
2. Accessories: Include vacuum relief valve, vacuum gauge, and drain.

D. Mounting Frames: Fabricate base and attachment to vacuum pump and components with reinforcement strong enough to resist movement during a seismic event when base is anchored to building structure.

2.3 MEDICAL VACUUM PACKAGED SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Becker Pumps Corp**]
4. [**EMSE Corporation**]
5. [**Ohio Medical Corporation**]
6. [**Powerex, Inc.**]
7. [**Tri-Tech Medical**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Becker Pumps Corp**]
4. [**EMSE Corporation**]
5. [**Ohio Medical Corporation**]
6. [**Powerex, Inc.**]
7. [**Tri-Tech Medical**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain medical vacuum packaged system from single source from single manufacturer.

D. Description: Medical vacuum packaged system, factory assembled on a common base, factory tested, fully compliant with NFPA 99 and featuring single-point connections for electrical power, vacuum intake, vacuum exhaust, and drains. Components are to include vacuum pumps, receiver, filters, all interconnecting piping, power, and control wiring, and UL-labeled control system.

E. Capacities and Characteristics:

1. Vacuum Service: [**Medical-Surgical**][**WAGD**]<**Insert service**> vacuum.
2. Vacuum Pump(s): [**Duplex**]<**Insert number**>, [**liquid ring**][**rotary screw**][**rotary claw**][**rotary vane, oil-less**][**rotary vane, oil-sealed**]<**Insert type**>.
3. Standard-Air Capacity of Each Vacuum Pump: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Vacuum Pump: <**Insert acfm (actual L/s)**> expanded air delivered.
5. Vacuum Required: [**20 in. Hg (510 mm Hg)**][**26 in. Hg (660 mm Hg)**]<**Insert value**>.
6. Mounting: [**Freestanding**][**Tank mounted**].
7. Motor (Each Vacuum Pump):
   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.
8. Electrical Characteristics:
   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.

e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

9. Receiver:

a. Orientation: [**Horizontal**][**Vertical**] arrangement.
b. Capacity: <**Insert gal. (L)**>.
c. Pressure Rating: [**100 psig (690 kPa)**]<**Insert value**> minimum.
d. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
e. Drain: [**Automatic**][**Manual**] valve.

10. Control System:

a. Description: Duplex mounted and wired control system.

1) UL labeled.
2) NEMA ICS 6, Type 12 control panel enclosure.
3) Circuit-breaker disconnects for each motor with external operators.
4) Full voltage motor starters with overload protection.
5) 24 V control circuit.
6) 65k AIC SCCR rating.
7) Touchscreen controls.
8) Screen displays and functions (to include, but not limited to, the following):

a) Service alerts.
b) Runtime hours.
c) System status.
d) System vacuum level.
e) Event logs.
f) <**Insert type**>.

9) Ethernet connectivity with embedded web page for remote monitoring.
10) Integral connectivity to the medical gas network via Ethernet.
11) Optional connectivity - BACnet communication with TCP/IP protocol.

11. Optional Accessories:

a. <**Insert type**>.

2.4 VACUUM PUMP PACKAGED SYSTEM - LIQUID RING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BeaconMedaes**]
2. [**EMSE Corporation**]
3. [**Flowserve SIHI**]
4. [**Gardner Denver, an Ingersoll Rand business**]
5. [**Nash; an Ingersoll Rand Business**]
6. [**Ohio Medical Corporation**]
7. [**Travaini Pumps USA, Inc**]

8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BeaconMedaes**]
2. [**EMSE Corporation**]
3. [**Flowserve SIHI**]
4. [**Gardner Denver, an Ingersoll Rand business**]
5. [**Nash; an Ingersoll Rand Business**]
6. [**Ohio Medical Corporation**]
7. [**Travaini Pumps USA, Inc**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain liquid-ring vacuum pumps from single source from single manufacturer.

D. Description: Packaged system.

E. Vacuum Pump(s): Nonpulsating, rotary, liquid-ring type.

1. Construction: [**Cast-iron body and**][**Cast-iron body with bronze**][**Bronze body and**] rotor.
2. Coupling: Nonlubricated, flexible type.
3. Sealing Fluid: Potable water with up to 90 percent recirculation.

F. Receiver: ASME construction steel tank with vacuum relief valve.

G. Outlet silencers and water-vapor separators on discharge connections.

H. Capacities and Characteristics:

1. Vacuum Service: [**Dental**][**Laboratory**]<**Insert service**> vacuum.
2. Vacuum Pump(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Vacuum Pump: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Vacuum Pump: <**Insert acfm (actual L/s)**> expanded air delivered.
5. Vacuum Required: [**8 in. Hg (205 mm Hg)**][**10 in. Hg (255 mm Hg)**][**12 in. Hg (305 mm Hg)**]<**Insert value**>.
6. Mounting: [**Freestanding**][**Tank mounted**].
7. Motor (Each Vacuum Pump):

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

8. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

9. Receiver:

    a. Orientation: [**Horizontal**][**Vertical**] arrangement.

b. Capacity: <**Insert gal. (L)**>.
c. Pressure Rating: [**100 psig (690 kPa)**]<**Insert value**> minimum.
d. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
e. Drain: [**Automatic**][**Manual**] valve.

2.5 VACUUM PUMP PACKAGED SYSTEM - ROTARY SCREW, OIL SEALED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BeaconMedaes**]
2. [**Kaeser Compressors, Inc**]
3. [**Quincy Compressor**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BeaconMedaes**]
2. [**Kaeser Compressors, Inc**]
3. [**Quincy Compressor**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain rotary-screw, oil-sealed vacuum pumps from single source from single manufacturer.

D. Description: Packaged system.

E. Vacuum Pump(s): Single-stage, oil-sealed, rotary screw type.

1. Coupling: Nonlubricated, flexible type.
2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air-pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal-bypass valve.
3. Air/Coolant Receiver and Separation Systems: **150 psig (1035 kPa)** rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal-bypass valve.
4. Capacity Control: Capacity modulation between zero and 100 percent vacuum delivery. Include necessary control to hold constant vacuum. When vacuum demand is zero, unload unit by using vacuum switch and blowdown valve.

F. Receiver: ASME construction steel tank with vacuum relief valve.

G. Outlet silencers on discharge connections.

H. Capacities and Characteristics:

1. Vacuum Service: [**Dental**][**Laboratory**]<**Insert service**> vacuum.
2. Vacuum Pump(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Vacuum Pump: <**Insert scfm (standard L/s)**> free air.

4. Actual-Air Capacity of Each Vacuum Pump: <**Insert acfm (actual L/s)**> expanded air delivered.
5. Vacuum Required: [**20 in. Hg (510 mm Hg)**][**26 in. Hg (660 mm Hg)**]<**Insert value**>.
6. Motor (Each Vacuum Pump):

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

7. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

8. Receiver:

    a. Orientation: [**Horizontal**][**Vertical**] arrangement.
    b. Capacity: <**Insert gal. (L)**>.
    c. Pressure Rating: [**100 psig (690 kPa)**]<**Insert value**> minimum.
    d. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
    e. Drain: [**Automatic**][**Manual**] valve.

2.6 VACUUM PUMP PACKAGED SYSTEM - ROTARY CLAW, DRY

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Becker Pumps Corp**]
4. [**Busch Vacuum Solutions**]
5. [**EMSE Corporation**]
6. [**Ohio Medical Corporation**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Becker Pumps Corp**]
4. [**Busch Vacuum Solutions**]
5. [**EMSE Corporation**]
6. [**Ohio Medical Corporation**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain rotary-claw, dry vacuum pumps from single source from single manufacturer.

D. Description: Packaged system.

E. Vacuum Pump(s): Single-stage, rotary-claw, dry type.

1. Coupling: Nonlubricated, flexible type.
2. Cooling System: Air cooled.
3. Capacity Control: Capacity modulation between zero and 100 percent vacuum delivery. Include necessary control to hold constant vacuum. When vacuum demand is zero, unload unit by using vacuum switch and blowdown valve.

F. Receiver: ASME construction steel tank with vacuum relief valve.

G. Outlet silencers on discharge connections.

H. Capacities and Characteristics:

1. Vacuum Service: [**Dental**][**Laboratory**]<**Insert service**> vacuum.
2. Vacuum Pump(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Vacuum Pump: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Vacuum Pump: <**Insert acfm (actual L/s)**> expanded air delivered.
5. Vacuum Required: [**20 in. Hg (510 mm Hg)**][**26 in. Hg (660 mm Hg)**]<**Insert value**>.
6. Motor (Each Vacuum Pump):
   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.
7. Electrical Characteristics:
   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.
8. Receiver:
   a. Orientation: [**Horizontal**][**Vertical**] arrangement.
   b. Capacity: <**Insert gal. (L)**>.
   c. Pressure Rating: [**100 psig (690 kPa)**]<**Insert value**> minimum.
   d. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
   e. Drain: [**Automatic**][**Manual**] valve.

2.7 VACUUM PUMP PACKAGED SYSTEM - ROTARY VANE, OIL LESS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Becker Pumps Corp**]
4. [**Busch Vacuum Solutions**]
5. [**EMSE Corporation**]

6. [**Gardner Denver, an Ingersoll Rand business**]
7. [**Gast Manufacturing Inc**]
8. [**Ohio Medical Corporation**]
9. [**Powerex, Inc.**]
10. [**Thomas; an Ingersoll Rand Business**]
11. [**Tri-Tech Medical**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Becker Pumps Corp**]
4. [**Busch Vacuum Solutions**]
5. [**EMSE Corporation**]
6. [**Gardner Denver, an Ingersoll Rand business**]
7. [**Gast Manufacturing Inc**]
8. [**Ohio Medical Corporation**]
9. [**Powerex, Inc.**]
10. [**Thomas; an Ingersoll Rand Business**]
11. [**Tri-Tech Medical**]
12. <**Insert manufacturer's name**>

C. Source Limitations: Obtain rotary-vane, oil-less vacuum pumps from single source from single manufacturer.

D. Description: Packaged system.

E. Vacuum Pump(s): Nonpulsating, oil-less, rotary-vane type.

1. Cleanable inlet screens.

F. Outlet silencers on discharge connections.

G. Capacities and Characteristics:

1. Vacuum Service: [**Dental**][**Laboratory**]<**Insert service**> vacuum.
2. Vacuum Pump(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Vacuum Pump: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Vacuum Pump: <**Insert acfm (actual L/s)**> expanded air delivered.
5. Vacuum Required: [**20 in. Hg (510 mm Hg)**][**26 in. Hg (660 mm Hg)**]<**Insert value**>.
6. Mounting: [**Freestanding**][**Tank mounted**].
7. Motor (Each Vacuum Pump):

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

8. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.

f. Maximum Overcurrent Protection: <**Insert amperage**>.

9. Receiver:

a. Orientation: [**Horizontal**][**Vertical**] arrangement.
b. Capacity: <**Insert gal. (L)**>.
c. Pressure Rating: [**100 psig (690 kPa)**]<**Insert value**> minimum.
d. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
e. Drain: [**Automatic**][**Manual**] valve.

2.8 VACUUM PUMP PACKAGED SYSTEM - ROTARY VANE, OIL SEALED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Becker Pumps Corp**]
4. [**Busch Vacuum Solutions**]
5. [**EMSE Corporation**]
6. [**Ohio Medical Corporation**]
7. [**Powerex, Inc.**]
8. [**Quincy Compressor**]
9. [**Travaini Pumps USA, Inc**]
10. [**Tri-Tech Medical**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Becker Pumps Corp**]
4. [**Busch Vacuum Solutions**]
5. [**EMSE Corporation**]
6. [**Ohio Medical Corporation**]
7. [**Powerex, Inc.**]
8. [**Quincy Compressor**]
9. [**Travaini Pumps USA, Inc**]
10. [**Tri-Tech Medical**]
11. <**Insert manufacturer's name**>

C. Source Limitations: Obtain rotary-vane, oil-sealed vacuum pumps from single source from single manufacturer.

D. Description: Packaged system.

E. Vacuum Pump(s): Nonpulsating, oil-sealed, rotary-vane type.

1. Cleanable inlet screens.
2. Outlet silencers and oil-mist separators on discharge connections.

F. Receiver: ASME construction steel tank with vacuum relief valve.

G. Capacities and Characteristics:

1. Vacuum Service: [**Dental**][**Laboratory**]<**Insert service**> vacuum.
2. Vacuum Pump(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Vacuum Pump: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Vacuum Pump: <**Insert acfm (actual L/s)**> expanded air delivered.
5. Vacuum Required: [**20 in. Hg (510 mm Hg)**][**26 in. Hg (660 mm Hg)**]<**Insert value**>.
6. Mounting: [**Freestanding**][**Tank mounted**].
7. Motor (Each Vacuum Pump):
    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.
8. Electrical Characteristics:
    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.
9. Receiver:
    a. Orientation: [**Horizontal**][**Vertical**] arrangement.
    b. Capacity: <**Insert gal. (L)**>.
    c. Pressure Rating: [**100 psig (690 kPa)**]<**Insert value**> minimum.
    d. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
    e. Drain: [**Automatic**][**Manual**] valve.

2.9 TURBINE EXHAUSTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Spencer Turbine Co. (The)**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Spencer Turbine Co. (The)**]
2. <**Insert manufacturer's name**>

C. Source Limitations: Obtain turbine exhausters from single source from single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 99, "Health Care Facilities Code," for vacuum equipment and accessories for dental

vacuum systems.

F. Description: Factory-assembled, -wired, -piped, -tested, and -packaged; electric-motor-driven; air-cooled; continuous-duty turbine exhausters and separators suitable for HVE applications and capable of producing not less than [**12 in. Hg (305 mm Hg)**]<**Insert value**>.

G. Control Panel: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
2. Motor Controller: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120 V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Automatic control switches to alternate lead-lag turbine exhausters for duplex turbine exhausters.
7. Instrumentation: Include inlet turbine exhauster and separator vacuum gauges, hour meter, discharge-air temperature gauge, and control transformer.
8. Alarm Signal Device: For connection to alarm system to indicate when backup turbine exhauster is operating.
9. Air-Water Wet Separator: Vertical, steel tank constructed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols; and to withstand not less than [**25 in. Hg (635 mm Hg)**]<**Insert value**>.

    a. Airflow Inlet: Tangential, in sidewall near top.
    b. Wash-Down Assembly: Electric timer with devices to operate water spray nozzle.
    c. Water Spray Nozzle: Water inlet connection and nozzle in top head.
    d. Airflow Outlet: Centered, in top head.
    e. Cleanout: Handhold, in sidewall near bottom.
    f. Drain: Automatic type, and check valve in sidewall at bottom.
    g. Safety Valve: Vacuum relief valve.
    h. Gauge: Vacuum gauge, tank mounted or furnish for piping mounting.
    i. Directional Flow Valve: For installation in separator inlet piping.
    j. Silencer: For installation in turbine exhauster outlet piping.

H. Miscellaneous Devices: Safety valves, inlet vacuum gauges, and shutoff valves.

I. Mounting Frame: Fabricate base and attachment to separator with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

J. Capacities and Characteristics:

1. Vacuum Service: [**HVE**]<**Insert service**> vacuum.
2. Turbine Exhauster(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Turbine Exhauster: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Turbine Exhauster: <**Insert acfm (actual L/s)**> expanded air delivered.
5. Vacuum Required: [**8 in. Hg (205 mm Hg)**][**10 in. Hg (255 mm Hg)**]<**Insert value**>.
6. Motor (Each Turbine Exhauster):

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

7. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

8. Separator:

   a. Capacity: <**Insert gal. (L)**>.
   b. Pressure Rating: [**100 psig (690 kPa)**]<**Insert value**> minimum.
   c. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
   d. Liquid-Level Sensors: [**Automatic electric**][**Automatic electric or mechanical float switch**][**Mechanical float switch**] to operate drain valve.

2.10 VACUUM PUMP PACKAGED SYSTEM - DIAPHRAGM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ACI Medical, Inc**]
2. [**Air Dimensions, Inc.**]
3. [**Gardner Denver, an Ingersoll Rand business**]
4. [**Gast Manufacturing Inc**]
5. [**KNF Neuberger, Inc**]
6. [**Thomas; an Ingersoll Rand Business**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ACI Medical, Inc**]
2. [**Air Dimensions, Inc.**]
3. [**Gardner Denver, an Ingersoll Rand business**]
4. [**Gast Manufacturing Inc**]
5. [**KNF Neuberger, Inc**]
6. [**Thomas; an Ingersoll Rand Business**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain diaphragm vacuum pumps from single source from single manufacturer.

D. Description: Simplex, single-stage, oil-less, diaphragm vacuum pump.

E. Control: Adjustable vacuum switch.

F. Cleanable inlet screen.

G. Outlet silencer and oil-mist separator on discharge.

H. Mounting: Freestanding.

I. Capacities and Characteristics:

1. Vacuum Service: [**Laboratory**]<**Insert service**> vacuum.
2. Standard-Air Capacity of Each Vacuum Pump: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Vacuum Pump: <**Insert acfm (actual L/s)**> expanded air delivered.
4. Vacuum Required: [**10 in. Hg (255 mm Hg)**][**12 in. Hg (305)**]<**Insert value**>.
5. Motor:

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

6. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.11 DENTAL VACUUM PACKAGED SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air Techniques**]
2. [**DentalEZ**]
3. [**Midmark Corp.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air Techniques**]
2. [**DentalEZ**]
3. [**Midmark Corp.**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain dental vacuum systems from single source from single manufacturer.

D. Description: Factory-assembled, -tested, and -packaged; [**simplex**][**duplex**]<**Insert number**>; automatic, dental vacuum packaged system; suitable for dental applications and capable of producing not less than [**12 in. Hg (305 mm Hg)**]<**Insert value**>.

E. Simplex Vacuum Pump: For mounting on base or on floor.

1. Vacuum Pump: Brass water-injection or liquid-ring type with rubber isolators on feet. Include fitting and tubing for circulation of approximately 80 percent of water through vacuum pump.
2. Cabinet: Enameled steel; open construction[**with sound-insulated cover**]. Include control panel with adjustable vacuum control, manual on-off switch, on light, and vacuum gauge.
3. Dual-Voltage Control: Conversion unit for connection to 208 or 230 V ac power.

4. Water Filter: For installation in inlet water supply.
5. Backflow Preventer: Integral with unit or separate reduced-pressure-zone type for field installation in inlet-water supply piping. See Section 221119 "Domestic Water Piping Specialties" for separate backflow preventers.
6. Check Valve: For installation in vacuum pump suction.
7. Vacuum Relief Valve: For installation in vacuum pump suction.
8. Air-Water Separator: With integral control to release wastewater when unit is shut off.
9. Waste Muffler: For installation in vacuum pump waste piping.

F. Duplex Vacuum Pumps: For mounting on base or on floor.

1. Vacuum Pumps: Brass water-injection or liquid-ring type with rubber isolators on feet. Include fitting and tubing for circulation of approximately 80 percent of water through vacuum pump.
2. Cabinet: Enameled steel; open construction[**with sound-insulated cover**]. Include control panel with alternator, adjustable vacuum control for each vacuum pump, manual on-off switches, on light, and vacuum gauge.
3. Dual-Voltage Control: Conversion unit for connection to 208 or 230 V ac power.
4. Water Filter: For installation in inlet water supply.
5. Backflow Preventer: Integral with unit or separate reduced-pressure-zone type for field installation in inlet-water supply piping. See Section 221319 "Sanitary Waste Piping Specialties" for separate backflow preventers.
6. Check Valves: For installation in each vacuum pump suction.
7. Vacuum Relief Valves: For installation in each vacuum pump suction.
8. Air-Water Separators: With integral control to release wastewater when unit is shut off.
9. Waste Mufflers: For installation in each vacuum pump waste piping.

G. Capacities and Characteristics:

1. Vacuum Service: Dental [**vacuum**][**HVE**]<**Insert service**>.
2. Vacuum Pump(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Vacuum Pump: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Vacuum Pump: <**Insert acfm (actual L/s)**> expanded air delivered.
5. Vacuum Required: [**10 in. Hg (255 mm Hg)**][**12 in. Hg (305 mm Hg)**]<**Insert value**>.
6. Motor (Each Vacuum Pump):

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

7. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.12 DENTAL VACUUM SYSTEM CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air Techniques**]

2. [**DentalEZ**]
3. [**Midmark Corp.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air Techniques**]
2. [**DentalEZ**]
3. [**Midmark Corp.**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain dental vacuum system control panels from single source from single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 99, "Health Care Facilities Code," for vacuum equipment and accessories for dental vacuum systems.

F. Description: Wall-mounted type with visual indicators to indicate equipment in operation and to perform the following:

1. Shut off dental vacuum equipment.
2. Shut off water supply to dental vacuum equipment. Include solenoid-operated valve for installation in water piping.

G. Dental vacuum control panels may be combined with dental air control panels in single dental equipment control panels.

2.13 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Open, externally ventilated**][**Totally enclosed, nonventilated**][**Severe duty**][**Explosion proof**][**Dust-ignition-proof machine**].
2. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**].
3. Motor Bearings: <**Insert requirements**>.
4. Unusual Service Conditions:

    a. Ambient Temperature: <**Insert deg C**>.
    b. Altitude: <**Insert feet (meter)**> above sea level.
    c. High humidity.
    d. <**Insert conditions**>.

5. Efficiency: Premium efficient.
6. NEMA Design: <**Insert designation**>.
7. Service Factor: <**Insert value**>.
8. Electrical Characteristics:

a. Horsepower: <**Insert horsepower**>.
b. Volts: [**120**][**208**][**230**][**460**]<**Insert value**>.
c. Phase: [**Single**][**Poly**].
d. Hertz: 60.
e. Full-Load Amperes: <**Insert value**>.
f. Minimum Circuit Ampacity: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of vacuum piping to verify actual location before vacuum pump installation.

3.2 PREPARATION

A. Clean vacuum equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for [**laboratory vacuum**][**and**][**medical vacuum**] applications, in accordance with CGA G-4.1, "Cleaning of Equipment for Oxygen Service."

3.3 INSTALLATION OF VACUUM EQUIPMENT

A. Install [**medical**][**dental**] vacuum equipment for healthcare facilities in accordance with ASSE 6010 and NFPA 99.

B. Equipment Mounting:

1. Install [**vacuum producers**][**vacuum producers, except diaphragm vacuum pumps,**]<**Insert vacuum producer types**> on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"
3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

C. Install vacuum equipment anchored to substrate.

D. Orient equipment so controls and devices are accessible for servicing.

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Install the following devices on vacuum equipment:

1. Thermometer, Vacuum Gauge, and Pressure Relief Valve: Install on each vacuum pump receiver.
2. Drain Valves: Install on [**receivers**][**and**][**separators**]. Discharge receiver condensate over nearest floor drain. Discharge separator oral evacuation fluids by direct connection into sanitary waste piping system.

3.4 INSTALLATION OF DENTAL VACUUM SYSTEM

A. Install in accordance with ASSE 6010 and NFPA 99.

B. Install dental vacuum system units [**directly on floor**][**on concrete bases**] with [**restrained**]elastomeric mounts with a minimum deflection of <**Insert deflection**>. Vibration isolation devices and installation requirements are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Install control panels for dental vacuum equipment on wall near [**equipment**][**office entrance**]<**Insert location**>.

3.5 PIPING CONNECTIONS

A. Comply with requirements for water-supply piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for drain piping specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Comply with requirements for vacuum piping specified in Section 226213 "Vacuum Piping for Laboratory and Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to equipment, allow space for service and maintenance.

E. Connect vacuum piping to vacuum equipment, accessories, and specialties with shutoff valve and union or flanged connection.

F. Connect water supply to vacuum equipment that requires water. Include backflow preventer. Backflow preventers are specified in Section 221119 "Domestic Water Piping Specialties."

G. Comply with [**NFPA 99 and**]authorities having jurisdiction on location of vacuum exhaust discharge.

3.6 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.7 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.8 IDENTIFICATION

A. Identify laboratory vacuum equipment system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Identify medical vacuum equipment system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" and with NFPA 99.

3.9 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that vacuum producer outlet piping is clear.
5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings.
7. Check for proper seismic restraints.
8. Drain [**receiver**][**and**][**separator**] tank(s).
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.

B. Verify that vacuum equipment is installed and connected in accordance with the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in electrical Sections.

D. Prepare written report documenting testing procedures and results.

3.10 ADJUSTING

A. Adjust equipment to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.11 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY VACUUM EQUIPMENT

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Medical Vacuum Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum equipment concurrently with tests, inspections, and certification of [**medical compressed-air equipment**][**medical compressed-air piping**][**medical vacuum piping**][**and**][**medical gas piping**] systems.
2. Preparation: Perform medical vacuum equipment tests in accordance with requirements in NFPA 99 for the following:

    a. System operation test.
    b. <**Insert additional requirements**>.

3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical vacuum equipment.
4. Replace damaged and malfunctioning controls and equipment.
5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

    a. Inspections performed.
    b. Procedures and materials used.
    c. Test methods used.
    d. Results of tests.

6. Components will be considered defective if they do not pass tests and inspections and are to be replaced with new components.

C. Prepare test and inspection reports.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain vacuum systems.

END OF SECTION 43 11 43 00

SECTION 46 61 21 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HVAC water treatment.
2. Manual chemical-feed equipment.
3. Automatic chemical-feed equipment.
4. Ozone-generator biocide equipment.
5. Stainless steel pipes and fittings.
6. UV biocide equipment.
7. Chemical-treatment test equipment.
8. Chemicals.
9. Inhibited ethylene glycol and propylene glycol.
10. HVAC makeup-water softener.
11. RO equipment for HVAC makeup water.
12. Filtration equipment.

1.2 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. PPM: Parts per million.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

E. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. TDS controllers.
6. TSS controllers.
7. Biocide feeder timers.
8. Chemical solution tanks.
9. Injection pumps.
10. Ozone generators.
11. UV-irradiation units.

12. Chemical test equipment.
13. Chemical material safety data sheets.
14. Inhibited ethylene glycol.
15. Inhibited propylene glycol.
16. Water softeners.
17. RO units.
18. Multimedia filters.
19. Self-cleaning strainers.
20. Replaceable bag- or cartridge-type filters.
21. Centrifugal separators.

B. Shop Drawings: Pretreatment equipment and chemical- [**and ozone-generator-biocide-**][**and UV-irradiation-biocide-**] treatment equipment, showing tanks, maintenance space required, and piping connections to HVAC systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For [**chemical-treatment equipment**][**water softeners**][**RO equipment**][**water-filtration units**] and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

E. Water Analysis: Illustrate water quality available at Project site.

F. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, [**water softeners,**][**RO equipment,**][**water-filtration units,**] and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 HVAC WATER TREATMENT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**LiquiTech, Inc.**]
9. [**Metro Group, Inc. (The)**]
10. [**Nalco; an Ecolab company**]
11. [**Sonitec-Vortisand Inc.**]
12. [**Suez Water Technologies (Formerly GE Water)**]
13. [**Watcon, Inc**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**LiquiTech, Inc.**]
9. [**Metro Group, Inc. (The)**]
10. [**Nalco; an Ecolab company**]
11. [**Sonitec-Vortisand Inc.**]
12. [**Suez Water Technologies (Formerly GE Water)**]
13. [**Watcon, Inc**]
14. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems as indicated in this Specification. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including [**hot-water heating below 250 deg F (120 deg C)**][**chilled water**][**dual-temperature water**][**glycol heating**][**and**][**glycol cooling**] shall have the following water qualities:

1. pH: Maintain a value within <**Insert range**>.
2. Alkalinity: Maintain a value within <**Insert range**> mg/L as CaCO(3).
3. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
4. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert number**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
5. Scale Control: Provide softened water for initial fill and makeup. [**Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.**]
6. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
7. Microbiological Limits:
    a. Total Aerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
    d. Sulfate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
    e. Iron Bacteria: Maintain a maximum value of <**Insert number**> organisms/mL.
8. <**Insert other applicable requirements**>.

D. Open hydronic systems, including [**condenser**][**and**][**fluid-cooler spray**] water, shall have the following water qualities:

1. pH: Maintain a value within <**Insert range**>.
2. Alkalinity: Maintain a maximum value of <**Insert range**> mg/L as CaCO(3).
3. Silica in Cooling Towers: Maintain a value no higher than <**Insert number**> mg/L.
4. Silica in Evaporative Condensers: Maintain a value no higher than <**Insert number**> mg/L.
5. Hardness in Cooling Towers: Maintain a value no higher than <**Insert value**> mg/L as CaCO(3).
6. Hardness in Evaporative Condensers: Maintain a value no higher than <**Insert value**> mg/L as CaCO(3).
7. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
8. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert value**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
9. Scale Control: [**Provide softened water for initial fill and makeup.**][**Provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.**]
10. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
11. Microbiological Limits:
    a. Total Aerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.

d. Sulfate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
e. Iron Bacteria: Maintain a maximum value of <**Insert number**> organisms/mL.

12. <**Insert other applicable requirements**>.

E. Passivation for Galvanized Steel:

1. Passivation of all galvanized-steel cooling towers and other system components must be conducted strictly in accordance with manufacturer's instructions in order to validate warranties. During the required passivation period, all water-quality parameters must be maintained in accordance with manufacturer's specifications, and all other requirements must be observed.

F. Steam Boiler and Steam Condensate:

1. Steam Condensate:

a. pH: Maintain a value within <**Insert range**>.
b. Alkalinity: Maintain a value no higher than <**Insert range**> mg/L as CaCO(3).
c. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
d. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert value**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
e. Ammonia: Maintain a value of <**Insert number**> mg/L.
f. <**Insert other requirements if necessary**>.

2. Steam boiler operating at **100 psig (690 kPa)** and less shall have the following water qualities:

a. Silica: Maintain a value no higher than <**Insert value**> mg/L as SiO(2).
b. TSS: Maintain a value no higher than <**Insert value**> mg/L.
c. TDS: Maintain a value no higher than <**Insert value**> mg/L.
d. Total Alkalinity: Maintain a value no higher than <**Insert value**> mg/L as CaCO(3).
e. pH: Maintain a value within <**Insert range**> pH.
f. <**Insert other applicable requirements**>.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum **3-1/2-inch (89-mm)** fill opening in the top, and **NPS 3/4 (DN 20)** bottom inlet and top side outlet. Provide quarter- turn or threaded fill cap with gasket seal and diaphragm arranged to lock the top onto the feeder when exposed to system pressure in the vessel. Provide a **NPS 3/4 IN (DN 20)** quarter-turn valve on inlet and outlet.

1. Capacity: [**2 gal. (7.6 L)**][**5 gal. (19 L)**]<**Insert value**>.
2. Minimum Working Pressure: [**125 psig (860 kPa)**][**175 psig (1210 kPa)**]<**Insert value**>.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter, Oscillating Piston:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.

5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Provide an electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

B. Water Meter, Turbine Type, Threaded:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **100 psig (690 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Provide an electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

C. Water Meter, Turbine Type, Flanged:

1. AWWA C701, turbine-type, totalization meter.
2. Body: [**Bronze**][**Epoxy-coated cast iron**].
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Flanged.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Provide and electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

D. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Programmable timers with infinite adjustment over full range, mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.

5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

E. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low-pH-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.

F. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:

    a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
    b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

G. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from 0.001 mg/L to 50 g/L. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 4X enclosure.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. [**Forms of digital communication:**][**MODBUS RS-232**][**MODBUS RS-485**][**Profibus DP**].
3. Digital display and touch pad for input.
4. Sensor probe adaptable to sample stream manifold.
5. High- or low-value-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.

H. Biocide Feeder Timer:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with

gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]

2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup, so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

I. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: [**30 gal. (114 L)**][**50 gal. (189 L)**][**120 gal. (454 L)**]<**Insert value**>.

J. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230500 "Common Work Results for HVAC."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints, except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.

L. Injection Assembly:

1. Quill: Minimum **NPS 1/2 (DN 15)** with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: [**Three**][**Two**]-piece stainless steel, as described in "Stainless Steel Pipes and Fittings" Article; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum **600 psig (4137 kPa)** at **200 deg F (93 deg C)**.

2.5 OZONE-GENERATOR BIOCIDE EQUIPMENT

A. Corona discharge generator with stainless steel generating cells and transformer housed in a NEMA 250, Type 4 enclosure. Assembly shall be suitable for continuous duty. Provide site glasses to verify proper operation of generator.

B. Water-cooled generators shall be provided with cooling water at maximum [**70 deg F (21 deg C)**]<**Insert value**> and [**35 psig (241 kPa)**]<**Insert value**>.

C. Generator vessels exposed to system pressure shall be constructed in accordance with 2017 ASME Boiler and Pressure Vessel Code and be equipped with pressure-relief valve.

D. External air compressor or induced airflow through a cleanable prefilter supplies concentrated oxygen through a molecular sieve, with **minus 62 deg F (minus 52 deg C)** dew point to avoid the formation of nitric acid.

E. Microprocessor-based control with software in EEPROM, surge protection, high-temperature cutout, and operational status lights.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]

F. Ozone Contactors:

1. Bubble diffusers.
2. Induction injection nozzle.
3. Injectors with static mixers.

G. Ozone Detector and Alarm Devices:

1. Detector:

a. Sensor: Metal dioxide semiconductor.
b. Concentration Range: [**0 to 10**]<**Insert range**> ppm.
c. Accuracy: Plus or minus 0.01 ppm.
d. Sensitivity: 0.01 ppm.
e. Response Time: Maximum 10 seconds.
f. Operating Temperature: **50 to 100 deg F (10 to 38 deg C)**.
g. Relative Humidity: 15 to 90 percent, noncondensing over the operating temperature range.

2. Horns:

a. Electric-vibrating-polarized type.
b. 24-V dc, with provision for housing the operating mechanism behind a grille.
c. Horns shall produce a sound-pressure level of 90 dBA, measured **10 feet (3 m)** from the horn.
d. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Visible Alarm Devices:

a. Xenon strobe lights listed in UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.
b. Rated Light Output: [**75**][**110**]<**Insert number**> candela.
c. Strobe Leads: Factory connected to screw terminals.

H. Self-Contained Breathing Apparatus: Open-circuit, pressure-demand compressed air includes completely assembled, portable, self-contained devices designed for hazardous breathing environment application.

1. Face Piece: EPDM or silicone rubber construction material, one-size-fits-all with double-sealing edge, stainless steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in mask, close-fitting nose piece to ensure no CO(2) buildup, and perspiration drain to avoid skin irritation and to prevent eyepiece, spectacle, and lens fogging.
2. Backplate: Orthopedically designed of [**chemical and impact-resistant, glass-fiber composite**][**aluminum**].

3. Harness and Carrier Assembly: Large triangular back pad, backplate, and adjustable waist and shoulder straps; modular in design, detachable components, and easy to clean and maintain. Shoulder straps are padded with flame-resistant material, reinforced with stainless steel cable, and attached with T-nuts, washers, and screws.
4. Air Cylinder: [**30**][**45**][**60**]-minute, low-pressure, air-supply-loaded [**fiberglass**][**aluminum**][**steel**] cylinders fitted with quick-fill assembly for refilling and air transfer.
5. Wall-Mounting Cabinet: Leakproof, corrosion-resistant, clear, plastic case.
6. Tested and Certified: By the National Institute for Occupational Safety and Health and by the Mine Safety and Health Administration, in accordance with 42 CFR 84, Subpart H.

2.6 STAINLESS STEEL PIPES AND FITTINGS

A. Stainless Steel Tubing: Comply with ASTM A269/A269M, Type 316.

B. Stainless Steel Fittings: Comply with ASTM A815/A815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and **250-psig (1725-kPa)** steam working pressure and **600-psig (4140-kPa)** cold working pressure ratings.

D. Three-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and **150-psig (1035-kPa)** steam working pressure and **600-psig (4140-kPa)** cold working pressure rating.

2.7 UV BIOCIDE EQUIPMENT

A. Target Irradiation: Minimum [**5,000 microWxs/sq. cm**]<**Insert value**>.

B. Light Source Vessels:

1. ASTM A666, Type 304 stainless steel.
2. Construct for minimum [**150 psig (1035 kPa)**]<**Insert value**> at [**150 deg F (65 deg C)**]<**Insert value**> in accordance with ASME Boiler and Pressure Vessel Code, and equipped with pressure-relief valve.
3. Light Source Sleeve: Quartz, with EPDM O-ring seals.
4. Light Source: Replaceable UV lamp producing minimum target irradiation of 254-nm wavelength light.

C. Controls: Interlock with pumps to operate when water is circulating.

2.8 CHEMICAL-TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, TSS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers; and oxidizing biocide test for open cooling systems.

B. Sample Cooler:

1. Tube: Sample.

a. Size: **NPS 1/4 (DN 8)** tubing.
b. Material: ASTM A666, Type 316 stainless steel.
c. Pressure Rating: Minimum **2000 psig (13 790 kPa)**.
d. Temperature Rating: Minimum **850 deg F (454 deg C)**.

2. Shell: Cooling water.

a. Material: ASTM A666, Type 304 stainless steel.
b. Pressure Rating: Minimum **250 psig (1725 kPa)**.
c. Temperature Rating: Minimum **450 deg F (232 deg C)**.

3. Capacities and Characteristics:

a. Tube: Sample.

1) Flow Rate: [**0.25 gpm (0.016 L/s)**]<**Insert value**>.
2) Entering Temperature: [**400 deg F (204 deg C)**]<**Insert value**>.
3) Leaving Temperature: [**88 deg F (31 deg C)**]<**Insert value**>.
4) Pressure Loss: [**6.5 psig (44.8 kPa)**]<**Insert value**>.

b. Shell: Cooling water.

1) Flow Rate: [**3 gpm (0.19 L/s)**]<**Insert value**>.
2) Entering Temperature: [**70 deg F (21 deg C)**]<**Insert value**>.
3) Pressure Loss: [**1.0 psig (6.89 kPa)**]<**Insert value**>.

C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. [**Two**]<**Insert number**>-station rack for closed-loop systems.
2. [**Four**]<**Insert number**>-station rack for open-loop systems.

2.9 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

B. Chemicals for direct steam injection humidification and for steam used in direct contact with food to be FDA approved and safe for these uses.

C. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range, with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum <**Insert grains/cu. ft. (kg/cu. m)**> of calcium carbonate of resin when regenerated with <**Insert lb (kg)**> of salt.
2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

2.10 INHIBITED ETHYLENE GLYCOL AND PROPYLENE GLYCOL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CORECHEM**]
2. [**Dynalene**]
3. [**Fremont Industries**]
4. [**Houghton Chemical Corp.**]
5. [**The Dow Chemical Company**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CORECHEM**]
2. [**Dynalene**]
3. [**Fremont Industries**]
4. [**Houghton Chemical Corp.**]
5. [**The Dow Chemical Company**]
6. <**Insert manufacturer's name**>

C. Inhibited Ethylene Glycol:

1. Ethylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
2. Inhibitor creates a passive layer on all surfaces that contact ethylene glycol to prevent corrosion by stabilizing fluid pH, to compensate for acids formed from glycol degradation.
3. pH value shall be maintained between <**Insert range**>, with reserve alkalinity greater than <**Insert number**> mL.
4. Operating Temperature Range: [**Minus 60 deg F (minus 51 deg C) to 250 deg F (121 deg C)**]<**Insert range**>.
5. Concentrated inhibited ethylene glycol is to be 95.5 percent ethylene glycol by weight and 4.5 percent performance additives.
6. Concentrated inhibited ethylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [**minus 20 deg F (minus 29 deg C)**]<**Insert number**>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at time of installation. Use only deionized water for mixing.
7. Provide only ethylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

D. Inhibited Propylene Glycol:

1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
3. pH value shall be maintained between <**Insert range**>, with reserve alkalinity greater than <**Insert number**> mL.
4. Operating Temperature Range: [**Minus 50 deg F (minus 46 deg C) to 250 deg F (121 deg C)**]<**Insert range**>.
5. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5

percent performance additives.

6. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [**minus 20 deg F (minus 29 deg C)**]<**Insert number**>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
7. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

2.11 HVAC MAKEUP-WATER SOFTENER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Hungerford & Terry, Inc**]
7. [**Kinetico Incorporated**]
8. [**Marlo Incorporated**]
9. [**Parker Boiler**]
10. [**Pentair, Inc.**]
11. [**RainSoft**]
12. [**Water King**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Hungerford & Terry, Inc**]
7. [**Kinetico Incorporated**]
8. [**Marlo Incorporated**]
9. [**Parker Boiler**]
10. [**Pentair, Inc.**]
11. [**RainSoft**]
12. [**Water King**]
13. <**Insert manufacturer's name**>

C. Description: Twin mineral tanks and one brine tank, factory mounted on skid.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event, when tank supports are anchored to building structure as recommended in writing by manufacturer.

F. Mineral Tanks:

1. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Fabricate and label fiber-reinforced plastic filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
3. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert value**> minimum.
4. Wetted Components: Suitable for water temperatures from [**40 to at least 100 deg F (5 to at least 38 deg C)**]<**Insert range**>.
5. Freeboard: 50 percent minimum, for backwash expansion above the normal resin bed level.
6. Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.
7. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
8. Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.
9. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging polyethylene strainers; arranged for even-flow distribution through resin bed.

G. Controls: Automatic; factory mounted on mineral tanks and factory wired.

1. Adjustable duration of regeneration steps.
2. Push-button start and complete manual operation override.
3. Pointer on pilot-control valve shall indicate cycle of operation.
4. Means of manual operation of pilot-control valve if power fails.
5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

    a. Slow opening and closing, nonslam operation.
    b. Diaphragm guiding on full perimeter from fully open to fully closed.
    c. Isolated dissimilar metals within valve.
    d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
    e. Float-operated brine valve to automatically measure the correct amount of brine to the softener, and refill with fresh water.
    f. Sampling cocks for soft water.

6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in **gallons (liters)** and that automatically resets after regeneration to preset total in **gallons (liters)** for next service run. Include alternator to regenerate one mineral tank with the other in service.

H. Brine Tank: Combination measuring and wet-salt storing system.

1. Tank and Cover Material: Fiberglass a minimum of **3/16 inch (4.8 mm)** thick; or molded polyethylene a minimum of **3/8 inch (9.5 mm)** thick.
2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
3. Size: Large enough for at least four regenerations at full salting.

I. Factory-Installed Accessories:

1. Piping, valves, tubing, and drains.
2. Sampling cocks.
3. Main-operating-valve position indicators.
4. Water meters.

J. Water Test Kit: Include in wall-mounted enclosure for water softener.

K. Capacities and Characteristics:

1. Continuous Service Flow Rate: <**Insert gpm (L/s)**> at **15-psig (104-kPa)** pressure loss.
2. Peak Service Flow Rate: <**Insert gpm (L/s)**> at **25-psig (173-kPa)** pressure loss.
3. Water Consumption: <**Insert gal./day (cu. m/day)**>.
4. Water Demand: <**Insert number**> hours/day.
5. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase: <**Insert value**>.
    c. Hertz: <**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.
    g. Interrupting Capacity: <**Insert amperage**>.

2.12 RO EQUIPMENT FOR HVAC MAKEUP WATER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Marlo Incorporated**]
7. [**Pentair, Inc.**]
8. [**Water & Power Technologies Incorporated**]
9. [**Water King**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Marlo Incorporated**]
7. [**Pentair, Inc.**]
8. [**Water & Power Technologies Incorporated**]
9. [**Water King**]
10. <**Insert manufacturer's name**>

C. Description: Factory fabricated and tested with RO membrane elements in housings, high-pressure pumps and motors, controls, valves, and prefilter; mounted on skid.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.

F. Skid Assembly: Welded-steel frame coated with epoxy protective finish.

G. RO Membrane and Housing:

1. Element: Thin-film composite with U-cup brine seal, with minimum 98 percent salt rejection based on 2000-ppm water supplied at **225 psig (1551 kPa)** and **77 deg F (25 deg C)**.
2. Housing: ASTM A666, Type 304 stainless steel, with PVC end caps held in place with stainless steel straps.

H. High-Pressure Pumps and Motors:

1. Pump:

a. Vertical, multistage, centrifugal pump, operating at 3500 rpm, with ASTM A666, Type 304 stainless steel casing, shaft, impellers, and inlet and discharge casting.
b. Bearings shall be tungsten carbide and ceramic.
c. Cast-iron frame and flanged suction and discharge connections.
d. Motor: NEMA-standard, C-faced, totally enclosed, fan-cooled motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

I. Controls:

1. Microprocessor-based controller with digital display.
2. Interlock for remote start/stop control.
3. Membrane flush sequence when pumps shut down.
4. Run time indicator.
5. Low-pressure safety cutoff.
6. Panel-mounted gages as follows:

a. Product and concentrate.
b. Inlet, cartridge filter outlet, RO feed, RO concentrate, and RO product pressures.
c. Product conductivity monitor.

J. Valves:

1. Stainless steel pump, concentrate, and recycle throttling valves rated for minimum **300 psig (2068 kPa)**.
2. Automatic inlet shutoff valve, diaphragm type; solenoid actuated, normally closed, and constructed of glass-reinforced noryl thermoplastic.
3. PVC valves with EPDM seats and seals for isolation at inlet, and check and sample valves at product and concentrate. Install sample valves at cartridge filter outlet, concentrate, and product outlet.

K. Prefilter:

1. Housing: Polypropylene with built-in relief or vent valve.
2. Element: Spun-wound polypropylene.

L. Inlet Water-Tempering Valve: Thermostatic water-tempering valve to maintain [**77 deg F (25 deg C)**]<**Insert value**> inlet water temperature to RO unit.

M. Activated Carbon Filter:

1. Media Tank: Fiberglass-reinforced polyester rated for minimum **150 psig (1035 kPa)** with internal backwash distributor and filtered water collector.
2. Media: 12-by-40-mesh, bituminous coal-based activated carbon.
3. Backwash Valve: Piston-operated control valve with drain-line, flow-control orifice.
4. Backwash Control: Seven-day time clock.

N. Atmospheric Storage Tank:

1. Tank: Polyethylene single piece with closed top and flat bottom with manway in top, 0.2-micron filter vent, inlet, discharge, and drain piping connections, and bulkhead fittings for level controls.
2. Control: Level switches start and stop RO unit. Low-level limit shall stop repressurization pumps and signal an alarm.

O. Repressurization Pumps:

1. Pumps: Two close-coupled, single-stage centrifugal pumps with mechanical seals. Wetted components are made of ASTM A666, Type 316 stainless steel.
2. Controls: NEMA 250, Type 4X pump control panel constructed of fiberglass to control pumps, one operating and one standby, with automatic alternator and fail-over control.
3. Motor: Open, drip-proof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

P. Water Test Kit: Include in wall-mounting cabinet for RO unit.

Q. Capacities and Characteristics:

1. RO Product Flow Rate: <**Insert gpm (L/s)**>.
2. Total Water-Flow Rate: <**Insert gpm (L/s)**>.
3. Daily Water Consumption: <**Insert gal./day (cu. m/day)**>.
4. Water Demand: <**Insert number**> hours/day.
5. Storage Tank Size: <**Insert gal. (L)**>.
6. RO Inlet Operating Temperature: [**77 deg F (25 deg C)**]<**Insert value**>.
7. High-Pressure Pump:

    a. Discharge Pressure: <**Insert psig (kPa)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Horsepower: <**Insert value**>.
    d. Motor Speed: [**3500**]<**Insert number**> rpm.

8. Repressure Pumps:

    a. Discharge Pressure: <**Insert psig (kPa)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Horsepower: <**Insert value**>.
    d. Motor Speed: [**3500**]<**Insert number**> rpm.

9. Prefilter Design (at Total Water-Flow Rate):

    a. Filter Efficiency: [**98**]<**Insert number**> percent.
    b. Particle Size: [**5**]<**Insert number**> microns and larger.
    c. Clean Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**>.

d. Replacement Pressure Loss: [6 psig (41 kPa)]<**Insert value**>.

10. Electrical Characteristics (Single-Point Connection):

a. Volts: <**Insert value**>.
b. Phase: <**Insert value**>.
c. Hertz: <**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.
g. Interrupting Capacity: <**Insert amperage**>.

2.13 FILTRATION EQUIPMENT

A. Multimedia Filters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diamond Water Conditioning; a Griesbach company**]
b. [**Everfilt**]
c. [**LAKOS Filtration Solutions**]
d. [**Miami Filter, Inc.**]
e. [**PEP Filters, Inc.**]
f. [**Puroflux Corporation**]
g. [**Sonitec-Vortisand Inc.**]
h. [**United Industries, Inc; Tower-flo Water Systems**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Diamond Water Conditioning; a Griesbach company**]
b. [**Everfilt**]
c. [**LAKOS Filtration Solutions**]
d. [**Miami Filter, Inc.**]
e. [**PEP Filters, Inc.**]
f. [**Puroflux Corporation**]
g. [**Sonitec-Vortisand Inc.**]
h. [**United Industries, Inc; Tower-flo Water Systems**]
i. <**Insert manufacturer's name**>

3. Description: Factory-fabricated and -tested, simplex, multimedia filter system, consisting of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.

a. Filter Tank: Corrosion resistant with distribution system and media.

4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

a. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel

Code: Section VIII, Division 1.

b. Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.

c. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.

d. Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.

e. FRP Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Type A, integral; [**Designation E, 125-psig (0.862-MPa)**][**or**][**Designation F, 150-psig (1.034-MPa)**] pressure category flanges of grade same as tank material, in accordance with ASTM D5421.

f. Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with [**EPDM**]<**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.

g. Strainer: Basket type mounted on pump suction.

h. Piping:

1) ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding or ductile-iron fittings.
2) **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

i. Safety Valves: Automatic pressure relief.

j. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

1) Casing: Radially split, cast iron.
2) Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**] minimum.
3) Impeller: ASTM B584 cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
4) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
5) Seal: Mechanical.
6) Motor: Open, dripproof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

k. Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.

1) Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure with time clock and pressure gages.
2) Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
3) Backwash: Automatic; with time clock and differential pressure switch.
4) Backwash Valve: Tank mounted with valves interlocked to single actuator.

l. Support: Skid mounting.[**Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event, when filter base is anchored to building structure.**]

5. Capacities and Characteristics:

a. Filter Design:

1) Water Flow: <**Insert gpm (L/s)**>.
2) Clean Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.
3) Maximum Media-Flow Rate: [**15 gpm/sq. ft. (10.2 L/s per sq. m)**]<**Insert value**>.

4) Filtration Efficiency: [**98**]<**Insert number**> percent.
5) Particle-Specific Gravity: [**1.8**]<**Insert number**>.
6) Particle Size: [**5**][**10**][**20**][**45**]<**Insert number**> microns.

b. Filter Tank: With internal distribution piping.

1) Pressure Rating: <**Insert psig (kPa)**>.
2) Diameter: <**Insert inches (mm)**>.
3) Inlet and Outlet Size: <**Insert NPS (DN)**>.
4) Blowdown Piping Outlet Size: <**Insert NPS (DN)**>.

c. Filter Media: <**Insert material**>.
d. Start Backwash Pressure Loss: [**13 psig (90 kPa)**]<**Insert value**>.
e. Backwash Period: [**10**]<**Insert number**> minutes.
f. Circulating Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Motor Speed: <**Insert number**> rpm.
4) Inlet Size: <**Insert NPS (DN)**>.
5) Outlet Size: <**Insert NPS (DN)**>.

g. Pump Motor Size and Electrical Characteristics:

1) Horsepower: <**Insert value**>.
2) Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
3) Phase: [**Single**][**Three**].
4) Hertz: [**60**]<**Insert number**> Hz.

h. Unit Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.
4) Interrupting Capacity: <**Insert amperage**>.

B. Self-Cleaning Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Everfilt**]
b. [**Hayward Flow Control; Hayward Industries, Inc.**]
c. [**Islip Flow Controls Inc.**]
d. [**Orival, Inc.**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Everfilt**]

b. [**Hayward Flow Control; Hayward Industries, Inc.**]
c. [**Islip Flow Controls Inc.**]
d. [**Orival, Inc.**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated and -tested, ASTM A126, Class B, cast-iron or steel, self-cleaning strainer system of tank, strainer, backwash arm or cleaning spiral, drive and motor, piping, and controls for removing particles from water.

   a. Fabricate and label ASTM A126, Class B, cast-iron or steel strainer tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Pipe Connections:

      1) NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.

4. Motorized Valves: Flanged or grooved-end, ductile-iron angle type with [**EPDM**]<**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.
5. Strainer: ASTM A666, Type 316 stainless steel.
6. Piping: ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding or ductile-iron fittings.
7. Safety Valves: Automatic pressure relief.
8. Backwash Arm Drive:

   a. Drive Casing: Cast iron.
   b. Worm Gears: Immersed in oil.
   c. Motor: Open, dripproof motor supported on the strainer-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

9. Controls: Automatic control of backwash; factory wired for single electrical connection.

   a. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure with time clock and pressure gages.
   b. Backwash Arm Drive: Automatic and manual switching; manual switch position bypasses safeties and controls.
   c. Backwash: Automatic; with time clock and differential pressure switch.
   d. Backwash Valve: Electric actuator.

10. Support: Skid mounting.[**Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist strainer movement during a seismic event, when strainer base is anchored to building structure.**]
11. Capacities and Characteristics:

    a. Strainer Design:

       1) Water Flow: <**Insert gpm (L/s)**>.
       2) Clean Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.
       3) Strainer Mesh: [**40**][**60**][**80**]<**Insert number**>.

    b. Strainer Tank: With internal distribution piping.

       1) Material: [**Cast iron**][**Steel**]<**Insert material**>.
       2) Pressure Rating: [**150 psig (1034 kPa)**]<**Insert value**>.
       3) Inlet and Outlet Size: <**Insert NPS (DN)**>.

4) Backwash Piping Outlet Size: <**Insert NPS (DN)**>.

c. Start Backwash: [**10 psig (69 kPa)**]<**Insert value**>.
d. Backwash Period: [**5**]<**Insert number**> minutes.
e. Drive Motor Size and Electrical Characteristics:

1) Horsepower: <**Insert value**>.
2) Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
3) Phase: [**Single**][**Three**].
4) Hertz: [**60**]<**Insert number**> Hz.

f. Unit Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.
4) Interrupting Capacity: <**Insert amperage**>.

C. Bag- or Cartridge-Type Filters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eden Equipment Company**]
b. [**Filtration Systems; Mechanical Mfg. Corporation**]
c. [**Hayward Flow Control; Hayward Industries, Inc.**]
d. [**Parker Hannifin Corp.; Process Filtration Div**]
e. [**Pentair, Inc.**]
f. [**PEP Filters, Inc.**]
g. [**Rosedale Products, Inc.**]
h. [**Shelco Filters**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eden Equipment Company**]
b. [**Filtration Systems; Mechanical Mfg. Corporation**]
c. [**Hayward Flow Control; Hayward Industries, Inc.**]
d. [**Parker Hannifin Corp.; Process Filtration Div**]
e. [**Pentair, Inc.**]
f. [**PEP Filters, Inc.**]
g. [**Rosedale Products, Inc.**]
h. [**Shelco Filters**]
i. <**Insert manufacturer's name**>

3. Description: [**Floor-mounted housing**][**Housing**] with filter [**bags**][**cartridges**] for removing particles from water.

a. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through [**bag**][**cartridge**]-type water filter; with [**bag support and**]base, feet, or skirt.

1) Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
2) Steel Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.
3) Plastic Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: **150-psig (1035-kPa)** plastic flanges.

b. Bag or Cartridge, Replaceable: Of shape to fit housing.

4. Capacities and Characteristics:

a. Filter Design:

1) Water-Flow Rate: <**Insert gpm (L/s)**>.
2) Filtration Efficiency: [**98**]<**Insert number**> percent.
3) Particle Size: [**10**][**20**]<**Insert number**> microns and larger.
4) Clean Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**>.
5) Pressure Loss at Replacement: [**6 psig (41 kPa)**]<**Insert value**>.

b. Housing:

1) Material: [**Carbon steel**][**Plastic**].
2) Pressure Rating: <**Insert psig (kPa)**>.
3) Seal Material: [**Nitrile rubber**]<**Insert material**>.
4) Diameter: <**Insert inches (mm)**>.
5) Height or Length: <**Insert inches (mm)**>.
6) Inlet and Outlet Size: <**Insert NPS (DN)**>.
7) Drain Size: [**Not applicable**]<**Insert NPS (DN)**>.
8) Bag Support Basket Material: [**Stainless steel**]<**Insert material**>.

c. Bag or Cartridge:

1) Number Required: <**Insert number**>.
2) Nominal Diameter: <**Insert inches (mm)**>.
3) Nominal Length: <**Insert inches (mm)**>.
4) Media Material: [**Cotton**][**Polyester**][**Polypropylene**]<**Insert material**>.

D. Centrifugal Separators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Culligan International Company**]
b. [**Griswold Water Systems**]
c. [**LAKOS Filtration Solutions**]
d. [**PEP Filters, Inc.**]
e. [**Puroflux Corporation**]
f. [**Rosedale Products, Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Culligan International Company**]
b. [**Griswold Water Systems**]
c. [**LAKOS Filtration Solutions**]
d. [**PEP Filters, Inc.**]
e. [**Puroflux Corporation**]
f. [**Rosedale Products, Inc.**]
g. <**Insert manufacturer's name**>

3. Description: Simplex separator housing, with baffles and chambers for removing particles from water by centrifugal action and gravity.
4. Housing: With manufacturer's proprietary system of baffles and chambers.

    a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
    c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
    d. Collection Chamber: Designed to hold separated particles.
    e. Outlet: Near top of unit.
    f. Purge: At bottom of collection chamber.
    g. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
    h. Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606. Provide stainless steel flanges if tank is stainless steel.

5. Motorized Purge Valve: Gate or plug pattern valve.

    a. Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with [**EPDM**]<**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.
    b. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Strainer: Stainless steel basket type mounted on pump suction.
7. Piping, Steel: ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding or ductile-iron fittings.
8. Piping, Copper: **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
9. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

    a. Casing: Radially split, cast iron.
    b. Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**] minimum.
    c. Impeller: ASTM B584 cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
    d. Shaft and Shaft Sleeve: Steel shaft with copper-alloy shaft sleeve.
    e. Seal: Mechanical.
    f. Motor: Open, dripproof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."
    g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

10. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.

a. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure.
b. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
c. Separator Purge: Automatic and manual.
d. TSS Controller Interlock: Open separator purge valve with bleed-off control.

11. Support: Skid mounting.[**Fabricate supports, base, and attachment to separator housing with reinforcement strong enough to resist separator movement during a seismic event, when separator base is anchored to building structure.**]
12. Capacities and Characteristics:

a. Separator Design:

1) Water-Flow Rate: <**Insert gpm (L/s)**>.
2) Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.
3) Separator Efficiency: [**98**]<**Insert number**> percent.
4) Particle-Specific Gravity: [**1.8**]<**Insert number**>.
5) Particle Size: [**5**][**10**][**20**][**45**]<**Insert number**> microns.

b. Housing:

1) Material: [**Steel**][**Stainless steel**][**Plastic**][**Fiberglass**]<**Insert material**>.
2) Pressure Rating: <**Insert psig (kPa)**>.
3) Diameter: <**Insert inches (mm)**>.
4) Height: <**Insert inches (mm)**>.
5) Inlet and Outlet Size: <**Insert NPS (DN)**>.
6) Purge Size: <**Insert NPS (DN)**>.

c. Circulating Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Motor Speed: <**Insert number**> rpm.
4) Inlet Size: <**Insert NPS (DN)**>.
5) Outlet Size: <**Insert NPS (DN)**>.

d. Pump Motor Size and Electrical Characteristics:

1) Horsepower: <**Insert value**>.
2) Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
3) Phase: [**Single**][**Three**].
4) Hertz: [**60**]<**Insert number**> Hz.
5) Full-Load Amperes: <**Insert value**>.
6) Minimum Circuit Ampacity: <**Insert value**>.
7) Maximum Overcurrent Protection: <**Insert amperage**>.
8) Interrupting Capacity: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drains.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water-testing equipment on wall near water-chemical-application equipment.

D. Install interconnecting control wiring for chemical-treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass Feeders: Install in closed hydronic systems, including[**hot-water heating,**][**chilled water,**][**dual-temperature water,**][**glycol heating,**][**and**][**glycol cooling**], and equip with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
2. Install water meter in makeup-water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

G. Install automatic fluid make-up equipment for glycol water system and include the following:

1. Chemical solution tanks.
2. Chemical solution injection pumps.
3. Water meter in makeup supply to system.
4. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

H. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:

1. Install makeup-water softener.
2. Install water meter in makeup-water supply.
3. Install inhibitor injection pumps and solution tanks with injection-timer-sensing contacts in water meter.

    a. Pumps shall operate for timed interval when contacts close at water meter in makeup-water supply connection.

4. Install test equipment and furnish test-kit to Owner.
5. Install RO unit for makeup water.
6. Install TDS controller with sensor and bleed valves.

    a. Bleed valves to cycle, to maintain maximum TDS concentration.

7. Install TSS controller with sensor and bleed valves.

a. Bleed valves to cycle, to maintain maximum TSS concentration.

8. Install inhibitor injection timer with injection pumps and solution tanks.

a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into main steam supply header.

I. Install automatic chemical-feed equipment for open [**condenser**][**fluid-cooler spray**] water and include the following:

1. Install water meter in makeup-water supply.
2. Install inhibitor injection pumps and solution tanks with injection-timer-sensing contacts in water meter.

a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

3. Install test equipment, and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install TDS controller with sensor and bleed valves.

a. Bleed valves to cycle, to maintain maximum TDS concentration.

5. Install TSS controller with sensor and bleed valves.

a. Bleed valves to cycle, to maintain maximum TSS concentration.

6. Install pH sensor and controller with injection pumps and solution tanks.

a. Injector pumps shall operate to maintain required pH.

7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

a. Injection pumps shall operate to feed biocide on an alternating basis.

8. Install ozone generator with diffusers in condenser-water piping.

a. Ozone generator shall operate continuously with condenser-water flow.

9. Install UV-irradiation lamps in condenser-water piping.

a. UV lights shall operate continuously with condenser-water flow.

3.3 INSTALLATION OF OZONE GENERATOR

A. Install ozone generator and equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Pipe ozone from ozone generator to condenser water with stainless steel pipe and fittings with welded

joints.

D. Install [**two**][**three**]-piece, stainless steel ball valve in ozone supply to condenser water.

E. Pipe cooling water to ozone generator and to air-gap drain fitting with stainless steel pipe and fittings with welded joints where enclosed in ozone-generator room.

F. Install [**two**][**three**]-piece, stainless steel ball valve in cooling water supply to ozone generator.

G. Mounting supports for ozone generator shall be ASTM A666, Type 316 stainless steel.

H. Mount breathing apparatus outside ozone-generator room.

I. Mount and install ozone detector, warning lights, and audible alarm inside ozone-generator room. Mount another set of warning lights and audible alarm just outside the main entrance to ozone-generator room.

3.4 INSTALLATION OF UV-IRRADIATION UNIT

A. Install UV-irradiation units on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for UV-irradiation units and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

3.5 INSTALLATION OF WATER SOFTENER

A. Install water softener equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals, and place specified mineral into mineral tanks.

E. Install water-testing sets on wall adjacent to water softeners.

3.6 INSTALLATION OF RO UNIT

A. Install RO unit and storage tank on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor RO unit and storage tank with pumps to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install interconnecting piping and controls furnished by equipment manufacturer but not factory installed.

D. Install water-testing sets on wall adjacent to RO unit.

3.7 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."

E. See Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.8 ELECTRICAL CONNECTIONS

A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.9 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation, and calibrate controls during the preliminary phase of HVAC system's startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

E. Equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report, advising Owner of changes necessary to adhere to "Performance Requirements" Article for each required characteristic. Sample boiler water at [**four**][**six**][**eight**]<**Insert number**>-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

H. At [**four**][**six**][**eight**]<**Insert number**>-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.

I. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Steam System: ASTM D1066.
3. Acidity and Alkalinity: ASTM D1067.
4. Iron: ASTM D1068.
5. Water Hardness: ASTM D1126.

3.10 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for [**cooling, chilled-water piping**][**heating, hot-water piping**][**heating, steam and condensate piping**][**steam and condensate system for humidifier and cooking appliance applications**][**condenser-water piping**] and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment. When training is complete, turn over video to Owner for future use.

END OF SECTION 46 61 21 00

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Task	Specification	Specification Description
46 82 00 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation
46 82 13 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation
46 82 23 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation
46 82 33 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation
46 82 36 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation
46 82 73 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation
46 82 76 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation

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SECTION 46 82 83 00 - SEWAGE TREATMENT PLANT ELECTRICAL CONTROLS AND INSTRUMENTATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of sewage treatment plant electrical controls and instrumentation. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Applicable Data
1. Flow diagrams, loop diagrams, and installation drawings of the existing instruments and sampling systems for which maintenance and repair is to be provided should be requested from the the Owner.

B. Instrumentation
1. All instrumentation shall be in accordance with the manufacturer's instructions.

1.3 EXECUTION

A. Scheduling and Coordination
1. Contractor shall determine that arrangements have been made to take the equipment out of service for the duration of the work.

B. General
1. Perform listed maintenance procedures and repairs on meter and sampling system in compliance with the manufacturer's recommendations.

C. Calibration
1. Calibrate meter over the meter's range and adjust to read correctly.

END OF SECTION 46 82 83 00

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Task	Specification	Specification Description
46 82 83 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation
46 82 91 00	46 86 29 00	Water Treatment Plant Electrical Controls And Instrumentation

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SECTION 46 86 29 00 - WATER TREATMENT PLANT ELECTRICAL CONTROLS AND INSTRUMENTATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of water treatment plant electrical controls and instrumentation. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. General
1. Items not specified but required for the proper installation or repair of a specified item of work shall be provided. Items shall be of proper type, size, design, and characteristics for the use intended. Parts shall be factory-made.

B. Finishes
1. Items replacing existing items that are galvanized, plated, painted, or otherwise finished shall be finished with like finish in compliance with the manufacturer's standard practice.

C. Electrical Controls and Instrumentation Components
1. Components for replacement purposes shall be designed for same service as the existing.

1.3 EXECUTION

A. Coordination
1. Contractor shall determine that requirements for removal of the equipment from service, the bypassing of control valves, and installing of temporary replacements have been coordinated with the the Owner. Bypassing of control valves or putting a control instrument in the Remote-Hand-Control mode will be done by the plant operators.

B. Power Supplies
1. Units that may be a hazard during the performance of the work shall be locked out.

C. Testing
1. Check the operation of each instrument after it is returned to service. Adjust each instrument to operate properly over the design range.

END OF SECTION 46 86 29 00

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01 42 13 00	01 00 00 00, 01 40 00 00, 01 42 00 00
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